JAN 5 1925
JAN 5 1925

ANNUAL HIGHWAY NUMBER

Engineering News-Record

This issue contains:

MORE than a score of pages devoted to articles on the design, construction, and maintenance of highways and on the administration of those staffs responsible for the construction of roads.

JANUARY ONE :: NINETEEN TWENTY-FIVE

Devoted to Civil Engineering and Contracting. McGraw-Hill Company, Inc.

KREOLITE

The Floor of Industrial America

THROUGHOUT industrial America, wherever a demand exists for floors that must withstand the maximum of rough use and abuse, regardless of conditions, *Kreolite Wood Blocks* are recognized as the ultimate in toughness, strength, endurance, economy and service.

An outstanding example is found in the country's greatest printing plants where floors are called upon to carry machinery and materials of enormous weight; to withstand the tremendous vibration of giant presses running at terrific speeds; to bear strains of ceaseless trucking and to defy even the repeated attacks of molten metal spilled in stereotyping and typecasting. Representative of the many big printing and publishing organizations using Kreolite Wood Block Floors are:

Crowell Publishing Co.	Chicago Tribune
Hearst Publishing Co.	New York Tribune
Ginn & Co.	Chicago Herald & Examiner
R. R. Donnelly & Sons Co.	Philadelphia Public Ledger

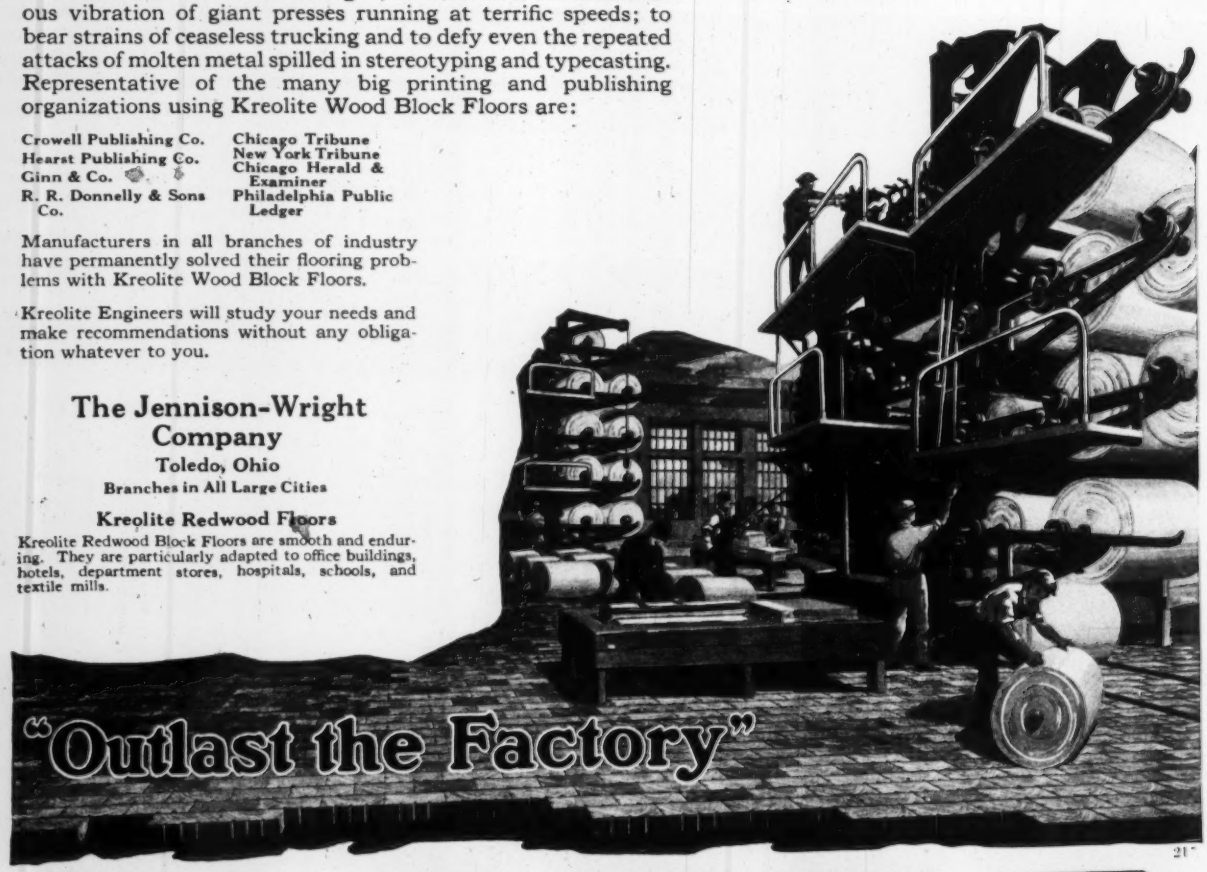
Manufacturers in all branches of industry have permanently solved their flooring problems with Kreolite Wood Block Floors.

Kreolite Engineers will study your needs and make recommendations without any obligation whatever to you.

The Jennison-Wright Company
Toledo, Ohio
Branches in All Large Cities

Kreolite Redwood Floors

Kreolite Redwood Block Floors are smooth and enduring. They are particularly adapted to office buildings, hotels, department stores, hospitals, schools, and textile mills.



21

FLOORS

WOOD BLOCK

Volume 94 New York, January 1, 1925 Number 1

Engineering News-Record

A CONSOLIDATION OF ENGINEERING NEWS, ENGINEERING RECORD, AND THE CONTRACTOR

FRANK C. WIGHT, *Editor*

New York
M. N. BAKER F. E. SCHMITT
C. S. HILL R. K. TOMLIN
J. W. SHAVER V. T. BOUGHTON

Chicago
W. W. DE BERARD
E. E. R. TRATMAN
San Francisco
N. A. BOWERS

Contents

Highway Snow Removal Practice Summarized 4
OVER A DOZEN STATES have large snow removal programs. Organization, equipment and costs reviewed. Heavy drift-removal equipment illustrated.
Engineering News-Record, January 1, 1925. 9¼ cols. Ill.

Bypass Roads Official Policy in Missouri 8
BY CARL W. BROWN.
Engineering News-Record, January 1, 1925. 2¾ cols. Ill.

Up-Keep of Road Maintenance Equipment— An Interview with W. A. Van Duzer 10
BY C. S. HILL.
HIGHLY ORGANIZED EQUIPMENT DIVISION in Pennsylvania keeps 4,000 equipment units costing $4,000,000 in service. Renews 20 per cent annually.
Engineering News-Record, January 1, 1925. 8¾ cols. Ill.

Sewage Screening and Composting Plant for New Rochelle, N. Y. 14
BY GEORGE W. FULLER.
Engineering News-Record, January 1, 1925. 1 col.

Hazards and Safeguards of Highway Structure 15
CHIEF DANGER POINTS: Width, car tracks, curves, parking space, cross-section, guard rails, clear view, bridges, intersections, crossings, detours, snow, signs, lighting. Precautions against hazards.
Engineering News-Record, January 1, 1925. 10½ cols. Ill.

Timber Road of Portable Sections Laid on California Desert 20
Engineering News-Record, January 1, 1925. 3¾ cols. Ill.

Engineer Board Reports on Chicago Drainage Canal 22
EPITOMIZED STATEMENT of conclusions of board of 28 engineers on Chicago Sewage Disposal by diversion from Lake Michigan and its effect on lake levels, water power and navigation.
Engineering News-Record, January 1, 1925. 8 cols.

State Land Settlement Proposed for South Carolina 25
Engineering News-Record, January 1, 1925. ¾ col.

Constructing Concrete Roads by Vibration 26
VIBRATION PRODUCES DENSE CONCRETE so hard that it can be walked over when green and is not injured by heavy rainfall.
Engineering News-Record, January 1, 1925. 7¼ cols. Ill.

Needed Tests on Structural Steel 29
BY FRANK BURTON.
Engineering News-Record, January 1, 1925. ¾ col.

From Job and Office 30
Protecting West Virginia Highways from Sliding Hill Damage.
Materials-Handling Practice on Ohio's "Stage Construction" Highways.
BY RAYMOND H. SMITH.
Army Rolling Kitchens Transformed Into Asphalt Heating Kettles.
BY LEO EHLINGER.
Burnt Shale as an Economical Road Surfacing.
BY O. L. HEMPHILL.
Combustion Chamber Increases Output of Asphalt Plant Sand Driers.
BY C. N. CONNER.
Oiled Sub-Base for Gravel Surfacing.
BY B. H. PIEPMEIER.
Vermont Finds Increasing Economy in Road Building by Force Account.
BY THURMAN W. DIX.
Earth Road Maintenance in Iowa.
BY W. H. ROOT.

Editorials 1
News of the Week 35
From the Manufacturer's Point of View 39
Business Side of Construction 42
Month's Prices of Construction Materials 44
Construction News 1
What and Where to Buy 248
Searchlight Section 124a
Index to Advertisers 256
Directory of Consulting Engineers 244

Revised Index Number for Volume of Work

Starting with the year 1925 a slight revision will be made in the basis of computing *Engineering News-Record's* Index Number for Volume of Construction Work. The Cost Index Number, however, remains the same.

The Volume Index Number, as is generally known by readers of this journal, is based on the year 1913. To date it has included both United States and Canadian construction work. One of the two revisions made is the elimination of Canadian construction. Henceforth Volume Index Number will represent United States construction only.

The second revision involves the detail of compensating the index number for variations caused by the fact that in some months work for five weeks is reported and in others for four weeks —this being due to the fact that *Engineering News-Record* is published every Thursday.

Calculated on the new basis, the Index Number for volume of construction will appear, as formerly, in the first issue of each month. In addition, there will be presented a tabulation of the numbers recalculated on the new basis for the twelve-year period 1913-1924 inclusive.

McGRAW-HILL COMPANY, INC., Tenth Ave. at 36th St., NEW YORK

JAMES H. McGRAW, President
ARTHUR J. BALDWIN, Vice-President
MALCOLM MUIR, Vice-President
E. J. MEHREN, Vice-President
MASON BRITTON, Vice-President
JAMES H. McGRAW, Jr., Vice-Pres. and Treas.
C. H. THOMPSON, Secretary

WASHINGTON, Colorado Building
CHICAGO, Old Colony Building
PHILADELPHIA, Real Estate Trust Building
CLEVELAND, Leader-News Building
ST. LOUIS, Star Building
SAN FRANCISCO, 883 Mission Street
LONDON, 6 Bouverie St., London, E. C. 4

Cable Address: "Machinist, N. Y."

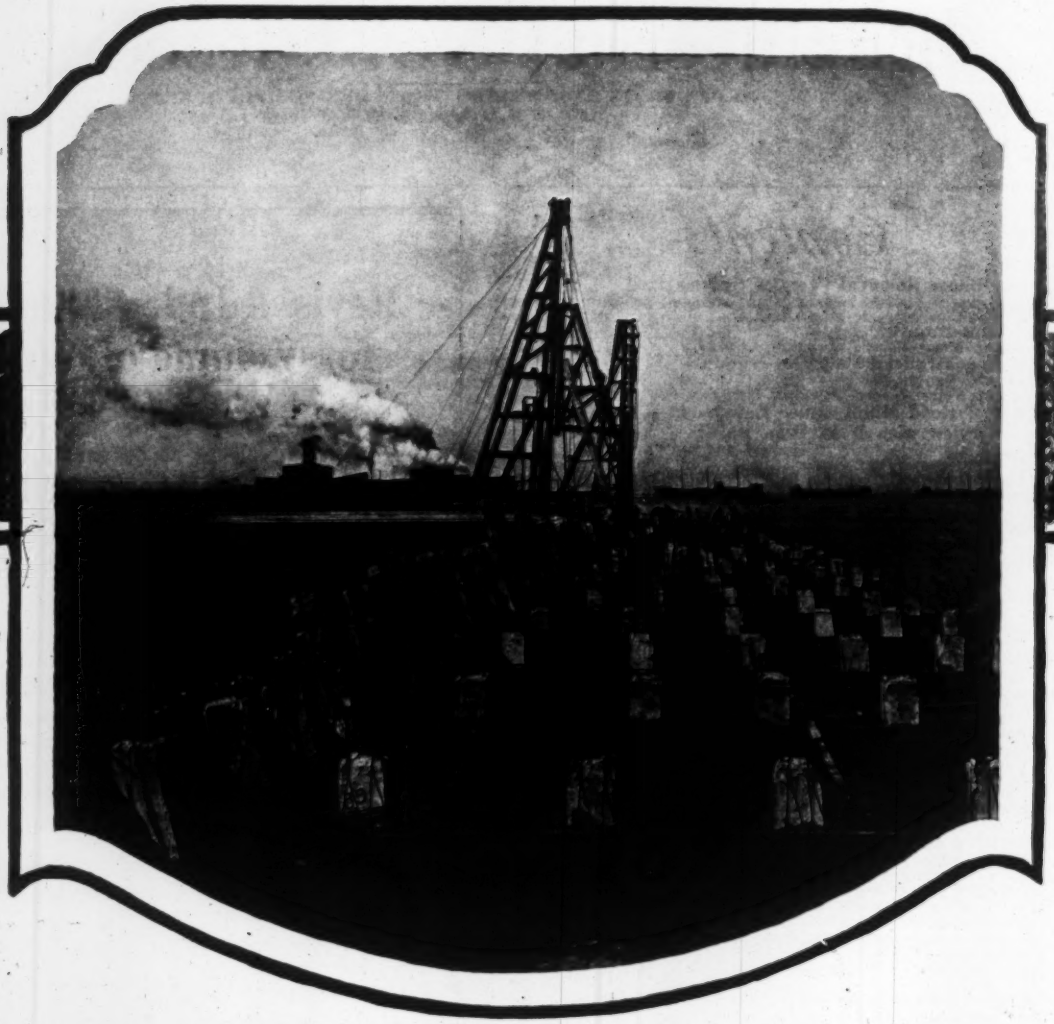
Publishers of
Engineering News-Record **American Machinist**
Power **Chemical and Metallurgical Engineering**
Coal Age **Engineering and Mining Journal-Press**
Ingeniería Internacional
Bus Transportation **Electric Railway Journal**
Electrical World **Electrical Merchandising**
Journal of Electricity (Published in San Francisco) **Industrial Engineer** (Published in Chicago)
Electrical Retailing
American Machinist—European Edition (Published in London)

Member Audit Bureau of Circulations. Member Associated Business Papers, Inc.

The annual subscription is $5 to any part of the United States, Canada, Mexico, Alaska, Hawaii, the Philippines, Porto Rico, Canal Zone, Cuba, Honduras, Nicaragua, Peru, Colombia, Bolivia, Dominican Republic, Panama, El Salvador, Argentina, Brazil, Spain, Uruguay, Costa Rica, Ecuador, Guatemala and Paraguay. Extra postage to other countries, $4 (total $9 or 38 shillings). Single copy, 25 cents.

Change of Address—When change of address is ordered the new and the old address must be given. Notice must be received at least ten days before the change takes place. Printed in U. S. A.
Copyright, 1925, by McGraw-Hill Company, Inc.
Published Weekly. Entered as second-class matter April 11, 1917, at the Post Office at New York under the act of March 3, 1879.

NUMBER OF COPIES PRINTED THIS ISSUE, 32,000



A Form for Every Pile— A Pile for Every Purpose

Piers, bridges, docks, bulkheads, anything unusual in reinforced concrete work — precast concrete piles, too —regular Raymond activities

RAYMOND CONCRETE PILE COMPANY

New York: 140 Cedar Street *Chicago:* 111 West Monroe Street

Canada: Montreal

BRANCH OFFICES IN PRINCIPAL CITIES

RAYM

A Consolidation of Engineering News, Engineering Record and The Contractor

ENGINEERING NEWS-RECORD

McGraw-Hill Company Inc.
JAMES H. McGRAW, *President*
E. J. MEHREN, *Vice-Ppresident*

DEVOTED TO CIVIL ENGINEERING AND CONTRACTING

FRANK C. WIGHT
Editor

Volume 94 NEW YORK, JANUARY 1, 1925 Number 1

For Road User as Well as Maker

FOR a number of years this journal has devoted a large part of the first issue each year to a review of the engineering progress of the year just past and a forecast of the year ahead. This custom will be continued, but the review will appear in the issue of Jan. 8 instead of in this issue—in order to permit the inclusion of more complete statistics in the review number and also to take advantage of the centering of interest on the Road Show at Chicago by concentrating in this issue a more than ordinary amount of material on that major engineering subject, highways. These articles are not only of instructive value to engineers and contractors directly concerned with highway work but they should catch the interest of every engineer, for there is no engineering activity that comes closer to the non-engineering life of the engineer today than the use of roads. On the assumption that it is no small part of our duty as an engineering journal to keep the engineer informed as to all those fields of engineering which touch the common life of the people we especially commend this issue to those who may not for the moment be making their living designing, building or operating roads. To the specialist in those fields it should require no special recommendation.

Highway Tax Theories

ONE of the fields of highway thinking in which leadership is needed is in the matter of financing. How are we to raise the billion dollars a year that our roads will require for some years to come? Who will pay the major part of this sum, the highway user or the general taxpayer? Is the benefit or the ability-to-pay theory of taxation best applicable to road financing? Will we be forced back into what we had thought to have discarded, the toll road and the toll bridge? Should there be a distinction in the sources of funds for maintenance and those for construction? These are most pertinent questions on which the engineer must be thinking and having thought must make his impress on the general thought. Reviews of the subject have lately been made by several national agencies, and a co-ordination of their conclusions, together with comment by this journal, will appear in the annual review issue of Jan. 8. The subject is as broad as all economics and as specific as any phase of engineering; it merits the best consideration of every engineer.

Will Engineers Measure Up?

ADMINISTRATION and operation are the keynotes of the leading articles which make up a large part of this issue. They presage a change that is growing in the affairs of highway officials. These no longer can be concerned solely with problems of construction. Even in those states where improved roads are sparse, operation is creeping close to construction in importance, and in the older road building states it is beginning to represent equal or greater expenditures. This should not merely be noticed as a fact. It is a fact in which lies golden opportunity for the highway industry. In particular it is an inspiration to engineering to show that it measures up to the demand for controlling thought in the enormous business of public roads transportation. In the preceding five words lies our thesis. It is the *business* of public roads transportation which challenges engineering skill and training. Construction is one element. Nationally it is the preponderating element and will for a time continue to overshadow other elements. Locally it has in many places assumed secondary importance. Sometime not very far away it will be subordinate everywhere. Then highway operation will make the large demand on invention and management, and construction will become a routine process. Will engineers measure up to this opportunity that lies ahead, or will they, as they did in the somewhat analogous railway development of a half century ago, let the control of this transportation agency get away from them?

A Golden Future

TODAY the engineer is supreme in the business as well as the technique of building roads. In the golden future of highway administration he must remain so. The bigness of the tasks of the public roads business is indicated by the subject heads of the articles in this issue: Safety, signals, traffic service, construction, maintenance. All are tasks essentially engineering in nature. In their performance the heritage of the engineer should be greatest. But it will not come to him if he lacks inspiration and enterprise to write his name distinctly as the logical heir. The estate is not in entail to him. Indeed in our governmental practices if anyone possesses this privilege it is the lawyer, the business man and above all the political worker. The highway engineer must by performance and creative energy place himself ahead of these others. Can he do it? Some have done it. Are there no others who are capable? The highway engineer must regard his work in a new aspect. He has to add to the habits of thought of the artisan those of the creative artist. It is not merely road building that he has to consider but the creation of a public roads transportation business. Still another thing he has to do is to compel the belief of the public that highway transportation is an engineering problem and that the engineer is the one most proficient in solving it.

Brief Against Day Labor

CONTRACTORS have no inalienable right to the construction work of the world. It has seemed often in the fractious discussions of day-labor construction which are currently being printed as if this truth were being forgotten—as if it were assumed that because the contractor is in the construction business he has sublime right to such construction as is being done. On sober thought no contractor really believes

this. If any contractor does believe it he is wrong because it is not so. If he talks as if he believed it he is foolish. The building public doesn't believe it and won't believe it. It believes that the contractor has a right only to that work which he can do as well as any other agency at less trouble and cost to the employer. And why should contractors want any greater consideration than this? They can save the owner from a multitude of worries and uncertainties inseparable from day-labor operations. They can do the work as well and in the vast majority of instances they can do it at less cost. There is much accumulated evidence in proof of all these facts and yet they have not been assembled anew in perhaps ten years. This should be done. Here then is a task which should appeal to those who again this year at the convention of the Associated General Contractors will ring the changes on invective against force account. A well presented brief is badly needed by contractors who have every so often to battle the hydra of force account construction of public works.

Signaling Highway Bridges

IT HAS come to be keenly appreciated in the past year or two that points of special hazard on a highway constitute traffic obstructions. Such hazards reduce the serviceability of the road. Every effort is being directed toward finding and eliminating them. Attention is being given to marking by proper signals those hazards which cannot be eliminated. Recognition of the dominating importance of special hazards was the main feature of last month's highway traffic conference in the Department of Commerce, where the subject was discussed in relation to curves, road intersections and similar critical points. Its relation to the special problems of the bridge engineer has been little emphasized.

Throughout our highway system, bridges form breaks in the continuity of the road, and thus constitute special hazards. They are narrower than the road, or they make an abrupt break in its alignment, or they introduce a sudden jog into the profile. Almost without exception they are not signaled; traffic has little warning of the approaching hazard.

Many bridge engineers have been aware of this condition for a number of years past. Their efforts in designing new structures have aimed at making the bridge an integral part of the road. But on the whole this view is still far from general acceptance. Design details and cost limitations have monopolized attention, and the loss of road value resulting from the construction of a bridge which forms a break in the roadway has been overlooked. Under the conditions of today this loss of value becomes daily more serious. We have progressed to the point where the principle of maintaining full traffic continuity on the road should be accepted as the first point of bridge design.

New bridges form a small part of the total, and even ideally perfect practice in present-day design will not alter the condition of existing structures. Of these, the great majority interrupt the traffic continuity of the highway and constitute special hazards. They need to be made safe for the same reasons that apply to road crossings and curves. In time it may be possible to improve many bridges by widening, by change of approaches or alignment, or by improvement of surface, but such betterment will be necessarily slow. Proper signaling is the first dependence for safety.

Who Uses Road-Building Equipment?

UNTIL recently contractors constituted the only sizable group of purchasers of road-building equipment. When the enactment of federal-aid legislation in 1916 gave a nationwide impetus to highway development, engineers of the state highway departments—and to a lesser extent those in county, township, and municipal service—found themselves facing the huge task of planning the traffic systems opened up by federal aid and getting construction started. Their principal efforts, naturally, were devoted to plans and surveys, selection of road types, preparation of designs and specifications, and supervision of construction. During these years of highway development the state highway engineer was not essentially a large equipment user, inasmuch as his duties were largely those of planning and direction of work by contractors.

The situation just outlined has changed materially within the last year or two. The federal-aid programs in the various states have now been under way long enough to have produced a considerable mileage of finished routes and upon the state highway departments devolves the duty of maintenance. Every year, as new construction is finished, the necessary mileage to be maintained is correspondingly increased. This maintenance work is done almost exclusively by the state's own forces, rather than by contract, so that the state highway engineer has greatly broadened the market for road-building machinery by himself becoming a direct user and a direct purchaser of equipment and materials. In road maintenance the same kinds of machines and the same kinds of materials are used as are employed in original construction.

Not all of the manufacturers of road-building equipment have sensed this change in the character of their market. In their promotional work they have featured their machines or their materials as aids to road *construction*. Very little has been said about the application of machinery to *maintenance*. For the maker of equipment, highway maintenance offers not only a continuing market but a market that is bound to show progressive enlargement during the next ten or twelve years at least, until the 172,000 miles of the 7-per cent federal-aid highway system are completed.

Two cases may be cited to indicate the growing importance of the state highway engineers' new role of direct user of machinery. In one representative Eastern state the highway department owns and operates with its own forces maintenance equipment valued at $4,000,000. The records of another state, in the Middle West, disclose an investment of $5,000,000 in road maintenance machinery. Assuming an average life of five years for the several types of machine in this quota, it is seen that in the first case equipment replacements alone will total $800,000 annually, and in the second case $1,000,000 annually, exclusive of sums spent for enlarging stocks of plant as the maintenance program assumes larger proportions.

These figures are significant. It will be interesting at the Good Roads Show in Chicago next week to see how they are reflected in the character of the machinery exhibits at the Coliseum. Will the makers of equipment appeal, through the products they display, only to the contractor who builds roads or also to the highway engineer who maintains them? For the manufacturer the field has developed a dual purchasing power.

Rights vs. Necessities at Chicago

THERE is no more complicated problem in the nice balance of rights and demands than that set up by the diversion of the waters of Lake Michigan to dispose of the sewage of the Chicago district. On the one hand we have a vast and congested municipal area, the health and comfort of whose inhabitants must be conserved; on the other we have the legal rights and equities of the potential uses of the water diverted by Chicago from its natural course. For further complication there are the relative rights and demands of two different inland waterway routes to the sea, the continued defiance of federal orders by a state-constituted municipal district, and the recent but rapidly growing prime importance of hydro-electric power in the life of the people. Add to this the confused status of the law of flowing water, especially when applied to interstate areas, and the delicate matter of the disposition of international water and the problem is complete in its intricacy.

This is the problem that was referred to the board of twenty-eight engineers, whose summarized report is presented in full in this issue. Just how much of the problem they considered within the scope of their study is not altogether clear, for the preliminary statement that they "studied the past procedure and the proposed future program of the Sanitary District of Chicago, and their effects upon all interests involved" is obvious generalization. It is to be assumed, however, that being a board of engineers they considered themselves qualified only to pass on the engineering questions involved and did not presume to offer expert opinion on the equally important legal controversies. That is, they could judge of the sanitary requirements of Chicago, both as to water supply and sewage disposal, the navigation requirements of the lakes and rivers involved and the power requirements, together with the hydraulic and hydrologic problems connected with all of these specific demands. They could not consider with authority either the legal status of Chicago or the legal questions of water diversion within the United States and as between the United States and Canada.

This view is supported by reading the summarized report. On engineering questions the board is definite and explicit. In the matter of interstate and international rights and obligations it is neither, for the whole disputed subject of the right of one city or state to divert large upstream flow from a downstream state user is not even touched, and the international contentions are passed over with the implication, which hardly reaches the force of a statement, that the Chicago diversion is a pre-treaty fact with which Canada can have no concern.

From the engineering side, the report completely upholds Chicago. It endorses the disposal of sewage through the Chicago River as the only practicable method, even considering the numerous improvements in sewage purification since that method was decided upon and taking into full account the program for both sewage and water purification to care for the growing population. The possibility that Chicago might be required to do as the other lake cities do, that is, utilize the lake itself for disposal, is dismissed as a "serious backward step in sanitation." The need for 10,000 sec.-ft. diversion, therefore, is urged "until such time as a re-appraisal shall indicate that the most beneficial use of the waters of the Great Lakes requires a consideration of the amount of such diversion." Less than one-half foot of lake lowering is admitted, but this, the board decides, can be readily restored by control works, which would not only maintain navigation depths but would provide reservoir capacity for downstream power production and thus take care of the claimed damages at Niagara; the full utilization of the St. Lawrence is considered so far off that the present diversion has no significance so far as it is concerned. The project for a Lakes-to-Gulf Waterway is approved to the extent that it is offered as an additional reason why the 10,000 sec.-ft. diversion should be continued.

All of this is stated in admirably concise language in the report, which is intentionally reduced to the lowest terms of the conclusions reached. The supporting data are to be included in a full report which is not yet completed, so that criticism or comment on the specific engineering findings should await the complete statement of the case. It is evident, however, that the board believes that the demands of Chicago are superior to the rights, or to put it in a less partisan fashion, the legalistic claims of the downstream users of the lake water. It is convinced—and it is high authority as to this—that there is no other way to insure the safe disposal of the city's sewage than by the use of at least 10,000 sec.-ft. down the Chicago River, with some additional precautions in the way of sewage treatment and better water supply and more careful water use. This is the head and front of its contention and from it all else follows. Such compensation as is due possibly injured parties—and the board apparently thinks their number is measurably restricted by the fact that Chicago has had long, though disputed, use of the water—is to be made by the construction of control works, partly at Chicago's expense, but the location of such works and the allocation of their costs must necessarily be left to diplomatic negotiation.

It is evident that the importance of the report lies in the engineering conclusions. In the long run the courts will have to adjudicate the superiority of necessities over rights and in such adjudication the unanimous opinion of so many eminent engineers—a unanimity which in itself adds much to the validity of the opinion—will have weight merely as expert judgment as to the extent of the necessities. Rights in water over such large areas as the Great Lakes and the Colorado basin have yet to be settled by the slow process of law, and the Chicago case will doubtless form one of the ruling cases out of which will be built the body of future law.

Indeed, the engineering report itself recognizes that possibility in the clause which suggests a future readjustment of the Chicago diversion at that time, around 1945, when the present program of the Drainage District as to sewage purification and water supply is completed. At that time, the board evidently considers, the demands of water power and navigation will have become so stabilized that the principles of rights and compensation will be better formulated than they are today. If Chicago accepts and honestly follows that suggestion it will have better standing with its neighbors and with those who claim that it has damaged them than it has in the past, when it constantly proceeded in defiance of courts and federal orders and with every indication that there was no limit to what it considered were its privileges in the use of the waters a few miles of whose shores it occupies.

HEAVY DUTY PLOW USED BY BUS LINES

Highway Snow Removal Practice Summarized

Over a Dozen States Have Large Snow Removal Programs—Organization, Equipment and Costs Reviewed—Heavy Drift-Removal Equipment Illustrated

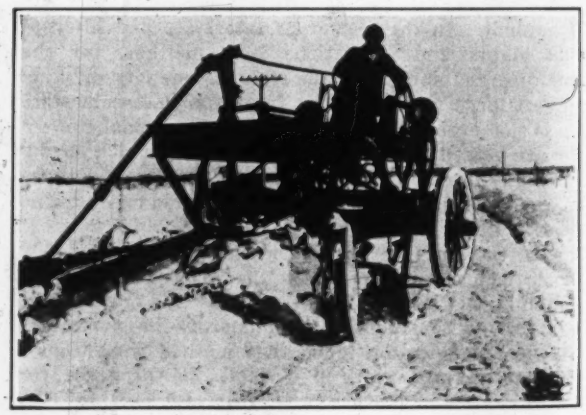
A SCORE of states accomplish something each winter in the way of snow removal from rural roads. The statistics are assembled only slowly, so in any statement of current mileage of highway from which snow is in some part removed, nothing better than an estimate is practicable. In the winter of 1923-24, the mileage was about 16,000 in states with some 50,000 miles of improved state road. Six states now are removing snow from the whole state system. Generally less than half the system is kept clear of snow. Each year the mileage is being increased. It is perhaps not extravagant, then, to assume that this winter, in the heavy snowfall states east of the Mississippi River, some 20,000 miles of main roads will in some degree be kept clear from snow. The activity, therefore, is one which in a large way is beginning to concern highway departments and manufacturers of equipment used in snow removal.

In discussing the subject it must be remembered that it is highway snow removal that is being considered and not the clearing of city streets, where the problems are quite different, especially in the fact that city snow has to be removed completely from the city, whereas rural highway snow can be pushed to the side, provided the roadway is cleared.

Advantages and Objections—Economically the benefits of snow removal are the value to trade and industry of having the highways usable by motor vehicles 100 per cent of the time instead of 70 to 80 per cent or some less portion. Obviously this value of year-around open roads must vary in different states and even in different parts of the same state. With full records of highway transport the gain could be readily estimated. These are not available except for a few places. The disposition, therefore, is to disregard refinements of traffic economics and clear such roads, up to the full state-road mileage, as judgment and the insistence of the users demand shall be cleared. Then again there comes in the sentimental and sociological value of the year-around open road which frequently overrides any decision based alone on economic benefits.

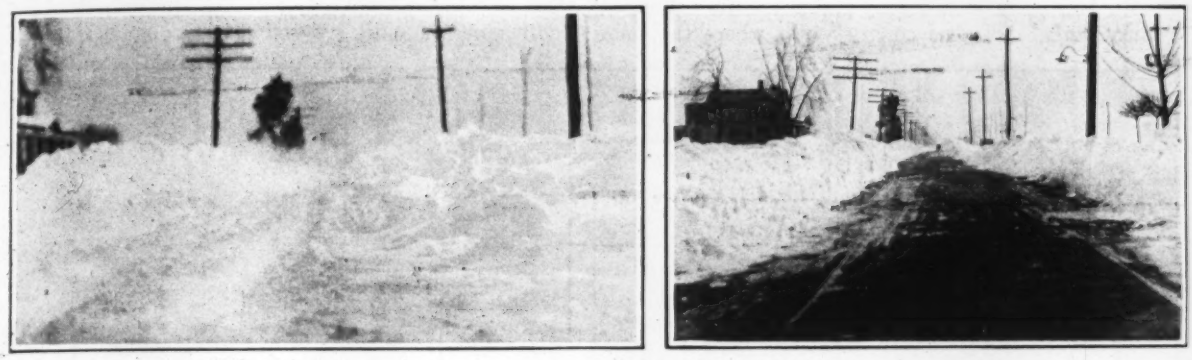
There is an advantage to the road structure from snow removal. With snow on the road ruts are formed by motor vehicles which cut down to the road surface and constant "tracking" of the traffic breaks down or ruts the road. These damages have occurred frequently in the east—New York, New Jersey and New England. By snow removal, the travel is distributed, as in the warmer seasons, over the width of the road. But to this end full-width snow removal is required, one-track removal causes the vehicles to "track" almost as intensively as do snow ruts.

Two chief objections have been urged against snow removal. One is economic—the claim that the cost of the work is excessive compared to the benefits gained. This may be dismissed, for: (1) The records are too meager of either cost or benefit to prove anything, and (2) the traveling public has decided that for large mileages it wants all-the-year-around highway service. The second objection is that uncovering the roads increases frost action, with the result that the heaving in spring is intensified. There is enough evidence, as noted in *Engineering News-Record*, Aug. 16, 1923, p. 250, to warrant serious consideration of this accusation. The subject requires study and it has not received any study of significance. At present, opinion favors the claim snow-cleared roads heave more than others.



BLADE GRADER USED FOR SNOW REMOVAL

Administration and Organization—Administration of snow removal corresponds generally to the administration of maintenance. It is (1) state, (2) state and county and (3) county and town. Two-thirds of the states doing any noticeable snow clearing have state direction. These too are the states in which removal is most comprehensive and thorough. County administration under state supervision and with state aid ranks second in importance. Town and county direction is least important. In some states where removal is by private interests, as bus lines and electric railways, there is virtually no public direction. So far as state roads are concerned the administration of snow removal is either state or county with state aid. Town and county operations and those of private interests are essentially local and special.



DURING AND AFTER A HEAVY SNOWSTORM ON A NEW JERSEY HIGHWAY

Authorities differ concerning the merits of the two leading plans of administration. The state administration advocates urge that where snow removal is left to the counties, they do not work toward through routes by co-ordinating their plans and operations and there result groups of roads, some well and promptly cleared and others not, instead of inter-county and interstate open roads. It is urged that state administration is more economical and the work done is of a better average quality. Granting that county administration is somewhat inferior in the respects just indicated, its advocates urge that it creates a sense of local responsibilty and arouses local pride of accomplishment. It puts the county officials in the position of workers and not of critics. All this generates, it is claimed, a strong sentiment for more road building and better upkeep.

As a matter of fact the line which separates road maintenance administration practice is the line which separates practice in snow removal administration. This is also true of the organization for snow removal. In all cases, in practice, it is formed from or around the regular maintenance organization. Two examples are illustrative. In Pennsylvania work is under the direct supervision of the maintenance engineer at headquarters and is performed by the state maintenance forces functioning exactly as for highway upkeep in summer. In New Jersey the maintenance personnel down to foremen plans, determines the time of and supervises snow removal mostly by contractors operating on a force-account basis. In states where the counties do the maintenance work they follow sometimes one and sometimes the other of these practices of snow removal.

Whatever form of administration the snow removal organization may have there are certain broad qualifications necessary. They are indeed paramount to form of organization.

1. The organization has to be able to spring into full activity at any time at day or night. Snowfall comes when it may. Also the modern theory of snow removal is to begin with the storm and follow close on its heels removing the snow as it accumulates. These conditions can be met only by an organization which, like the fire department of a city, can from comparative idleness get quickly into full working speed.

2. The organization has to "cover" the snow removal territory equally effectively everywhere. Snowstorms choose their own territory of attack. Every territory then must have its own defending forces ready to go into action.

3. The organization has to be capable, trained and self-sufficient in every unit. When the storm, as it easily may, cuts off communication every removal unit has to grapple and solve without aid its own difficulties.

4. The organization has to possess reserve capacity. A storm may be so protracted that relief crews and equipment have to be called and the fighting forces alternated.

5. The organization has to possess an intelligent system which promptly and surely gets and disseminates forecasts and news of snowfall. This is the nerve system of the whole working body and its perfect functioning is a major requirement of an efficient snow removal organization.

BLADE SNOW PLOW ATTACHED TO FRONT OF TRUCK

Methods and Equipment—With an efficient and live organization successful snow removal requires (1) A

definite removal program; (2) sufficient and efficient mechanical equipment; and (3) a determined mode of procedure. Experience shows that none of these requirements can be neglected and full success in keeping the roads open be secured.

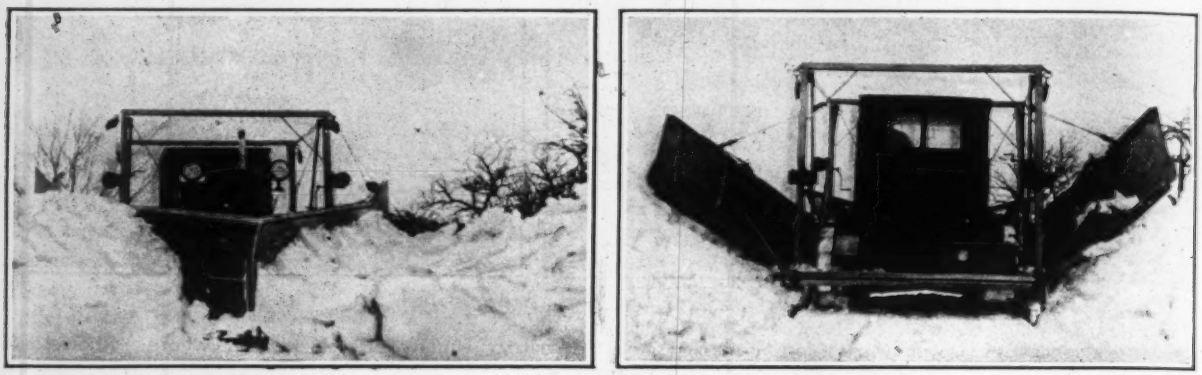
The extent of snow removal, or the mileage of cleared road, is determined by the economic and other considerations previously pointed out. With this road decided on there have to be determined (1) the physical division of the work, (2) the degree of removal and (3) the width of clearance. These constitute the removal program. Practice limits the length of section to about 15 miles. One foreman and crew handle a 12-mile section in New Jersey and a 10-mile section in Pennsylvania. In some county work, where the total cleared mileage is not great, a single crew and outfit covers the whole. Depth of removal for motor vehicle travel is invariably to the road surface. Exceptions are noted only where team and sledge traffic predominates. Width of removal is a function of traffic principally but it is also related to preservation of road structure. A brief development of the question is warranted.

Practice is virtually settled that the cleared width should be sufficient for two lines of traffic. This means that the ordinary 18- or 20-ft. pavement is completely uncovered. Any less cleared width will not handle a traffic great enough to justify the expense of snow removal. Also if a less width is cleared two conditions are held possible: (1) The traffic will seek a single track and tend to rut the road and (2) there will be deeper frost action under the uncovered center than under the blanketed edges and the danger of heaving will be increased. In Pennsylvania, which of all states removes snow from the greatest mileage, the removal width is 26 ft., or between ditches. It is believed there that clearing the full road width is well worth while in service to traffic and in preservation of road structure.

Procedure—There are two ways of proceeding in removing snow. The preferred practice is to begin with the storm and remove the snow as it accumulates until snowfall ceases. The other practice is to wait until the storm is over and then clear away the total fall. By one procedure the road is kept continuously open and by the other the traffic must buck the drifts until, sometime after the storm, the road is cleared. Progressive removal begins when the fall has reached 2 or 3 in., and then there is no stop as long as snowfall continues and the way is blocked. The detail of the procedure differs with different managers and outfits. Always the snow is swept half each way by traveling back and forth along the road with plows or other apparatus employed. Two considerations are of importance in the operation. One is always to keep the snow-banks well to the sides and the other is not to block entering roads.

No matter what may be the organization, the program or the equipment it is rarely undertaken, in case of a general snowfall, to clear the snow from all roads at the same time. The procedure is to attack the arterial roads first and then proceed to the routes less vital to transportation. Always it has to be kept in mind that snow removal is a traffic service.

Snow Removal Equipment—An inventory of the equipment for snow removal discloses no development of remarkable machines. Indeed the time has been short. It is not five years since snow removal became a rural road maintenance task of any importance. Still it may reasonably be questioned whether engineers and inventors have kept pace with the equipment problem of snow removal. As the outfits used by a dozen states are inventoried, the group impression is that snow removal equipment is adapted equipment. This is a condition which is open for some thought.



FRONT AND REAR OF V-PLOW, WITH WINGS, USED ON THE WISCONSIN STATE HIGHWAYS

Only general questions of equipment types and selection can be considered. The individual devices and makes are too numerous for mention. With hand tools, the types of snow removal equipment are: (1) Plows: a, Straight blade, and b, V-shaped; (2) rotary plows and brooms; and (3) special machines as rollers and melters. The bulk of all snow removal equipment is of the first type for reasons which will appear immediately. There are three principal qualifications required of all snow removal equipment: (1) Power operation, (2) speed of movement and (3) rugged construction. Of regular road maintenance equipment motor trucks and tractors possess these qualifications and, also, equipping them with either a blade or V-plow attachment is easy. So equipped, they have then become logically the leading snow removal device.

In a broad way the motor truck, with a straight-blade plow is the light snow removal device while the tractor and V-plow are used for clearing deep falls and drifts. Depth of fall which can be effectively handled by either device depends on the weight of the snow which may vary from 12 lb. to 22 lb. in two different storms. Roughly the truck with a straight plow will handle effectively up to 10 in. of light snow. However, as the depth goes up from 3 or 5 in. the speed is cut down.

The tractor and V-plow will handle far greater depths effectively than will trucks but like trucks it does its best work under less load. In brief to get the best out of either truck or tractor plows experience is unanimous in urging progressive removal. Successive light cuts as the snowfall accumulates also reduce wear and tear on the trucks and tractors—snow plowing is a hard test of both.

LIGHT PLOW USED BY BUS LINES

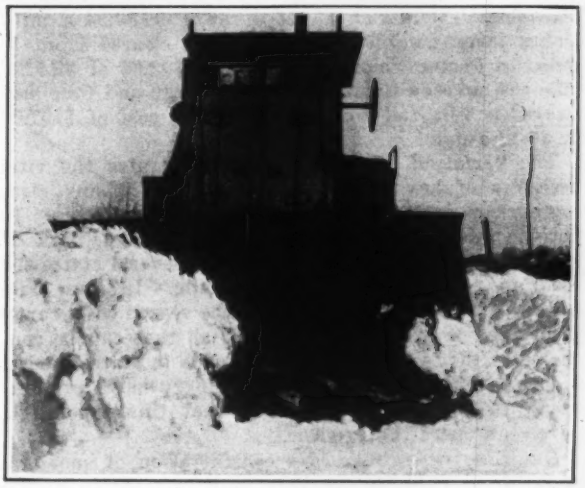
Deep snow and drift removal is not a truck and straight-blade-plow task. The desirable method always of course is to prevent the drifts and deep fall by keeping the snow cleared away as fast as it accumulates. In New Jersey the practice is often to allot a truck to a single forming drift. However, drifts and deep snow cannot always be escaped. The truck and blade plow is too light a tool—bucking drifts with it is soon discouraged by excessive breakage. In the East the shovel gang is rather favored for drift removal, while in Wisconsin and Michigan some very heavy drifts, 4 to 10 ft. deep, are handled by tractors and V-plows. Indeed, these states have studied drift conditions rather extensively.

Approaching the problem from the angle of drift prevention Wisconsin for three winters has carried on a snow drift survey to determine where drifts customarily form, their magnitude and from what direction they build up. Then snow fences were set up to break the drifting action. Generally these have been a help. For drift removal, tractors and V-plows have gained most favor. These outfits travel 3 to 4 miles an hour and will drive through drifts of 5 or 6 ft. Dickenson County in Michigan reports that with a similar outfit it handles drifts up to 4 ft. deep and of any length. In Connecticut very considerable reliance has been found warranted in snow fences and in weed and brush cutting to prevent drifts. The warning is given, however, that snow fence location is a particular task which cannot be put into everyone's hands.

There has been no very wide experience in snow removal with rotary snow plows or rotary sweepers. Isolated instances of their successful action are reported from Wisconsin and Connecticut. Some of the brooms made can be attached to motor trucks but generally the rotary type snow removing machine is an independent equipment unit and is a considerable investment compared with blade and V-plow attachments for trucks and tractors. These facts have held back their adoption. Rollers and other more special devices have such rare and special use that they are merely mentioned.

In general there comes from snow removal officials everywhere a demand for something more effective in snow removal devices or machines. The idea is not very clear but the thought appears to be to get away from the attachable plow notion. As one thoughtful road official said: "As we get into the niceties of snow removal we find the need of other apparatus and much of it especially designed."

Any attempt to arrive at the volume requirements of snow removal equipment is highly unsatisfactory. There are too many possible combinations of influencing factors. Then, too, the bulk of every snow removal outfit is regular maintenance equipment. Pennsylvania has one snow plow, about, for every 10 miles of road cleared, Connecticut one for every 8 miles and Massachusetts one for every 5 miles, about. New Jersey has some 130 plows for a 726-mile snow clearing program. These are as satisfactory figures as any and in reality they do not mean much. There is great need of record keeping in most states doing snow removal work.



V-PLOW USED IN PENNSYLVANIA FOR HEAVY SNOW

One factor of the snow removal equipment problem—it has to do with the fundamental requirement of readiness to get quickly into action—is universally emphasized. It is repairs and housing. Spare parts and repair facilities are to be watched in particular. In housing practice New Jersey is a good example. As trucks are relieved from summer maintenance service they are sent to the headquarters shops to be overhauled and have their snow plows attached. Then they go to local garages near the sections of road to which

they are assigned for snow removal. Then they are kept in heated storage, with plows attached, ballast in place and body jacked up off the springs. A crew of two drivers and one helper to each truck is ready to jump it onto the road as soon as the snow call is sounded.

Snow Removal Costs—Snow removal cost figures mean something or nothing according as the conditions under which they were incurred are fully stated. An announcement that snow removal cost a state $300 a mile indicates little. Even if the cost figure is accompanied by a record that the average fall was 45 in. information is lacking. If the 45 in. accumulated in two storms or in nine, if there was much or little drifting, if the snow was heavy or light and if the width cleared was 12 ft. or 26 ft., the costs reflected the condition. In general, therefore, costs of individual operations are more informative than blanket statistics of a state system.

From figures reported for a single storm, with no drifting, from four Wisconsin counties, by N. F. Isabella, assistant state maintenance engineer, the following summaries have been made:

In Kenosha County the fall was 7 in., a single blade plow on a truck operated by two men cleared 15 miles at an operating cost of $24 or $1.60 a mile. With eight trucks having single-blade plows and operated by 24 men a 4-in. fall was cleared from 80 miles in Milwaukee County at a cost of $795 or $9.94 a mile. Using three trucks an 8-in. fall was cleared from 44 miles in Racine County at a cost of $92.98 or $2.11 a mile. Waukesha County with two trucks and four men cleared a 5-in. fall from 32 miles at a cost of $197.60 or $6.18 a mile.

The variation of these figures illustrates the vital necessity of having all conditions given if any close comparison is to be made of snow removal costs. In noting mileage costs for a season the same lack of uniformity is observed. As given by several states the costs range from $50 to $325 a mile. In four Wisconsin counties not far separated the season costs range from $140 to $280 a mile. About all that can be concluded is that year-around open roads in states having a considerable snowfall is not an inexpensive proposition. It is to be observed too that this expense is purely an operating expense.

Bus Line Operations—No consideration of snow removal from roads is complete without mention of the work being done by bus transportation companies. It is necessary to observe also that these bus operators in many instances have developed methods and machinery for snow removal which have proved remarkably effective. This is particularly true of methods and machines for handling deep snow and drifts. For light falls bus line practice does not differ essentially from the best highway department practice previously indicated. Indeed the doctrine of snow removal developed in the best bus line practice may be expressed as: "Light cuts at high speeds and throw the snow far to the sides."

Considering the equipment for deep snow and drift removal bus practice favors the V-plow. So far the rotary plow has not been worked out to satisfaction. There are many arrangements of V-plow apparatus and some of the outfits weigh up to 12 or 15 tons. Some of the accompanying pictures explain bus line practice in more detail and highway engineers will find notable descriptions of methods and equipment in *Bus Transportation*, August, 1913, and September, 1924.

In concluding this review of snow removal from roads no better thought occurs than the statement of Charles J. Bennett, formerly state highway commissioner of Connecticut, as follows: "In conclusion, let it be said that snow removal is a very real problem with state highway department maintenance crews; that it will be a very real problem and increase in magnitude as long as we have motor vehicles; that the amount of money to be expended on snow removal will only be limited by the value of service to traffic; that the cost of snow removal will vary from $50 to $250 per mile, and in cases of extreme snowfall, the cost may run even higher. Much of the work is thrown away, discouraging, and must be done over again. The permanent results are practically nothing. The work is done for the purpose of providing facilities for the motor vehicle."

Bypass Roads Official Policy in Missouri

Main Trunk Roads Skirt Towns When Distance Is Not Changed and Local Traffic Is Not Discommoded

By Carl W. Brown
Assistant Chief Engineer, Missouri State Highway Commission, Jefferson City, Mo.

ONE OF the problems which the state of Missouri is confronting with its road-building program, is the difficulty of getting the large volume of traffic on the more important state roads through or around the congestion that exists upon many of the city streets in the larger cities.

Until the last few years this condition had not been considered. In fact very little, if any, attention had been paid to the location of main highways through or around cities. With slow-moving and horse-drawn vehicles the tendency had been to connect the outlying roads and to bring them into the main or business section of the city by the most direct route, consistent with easy grades, that was possible. This did not present a very serious difficulty when the traffic using a street usually originated within a radius of a few miles, seldom exceeding 30 miles.

Under present conditions, however, many main highways are carrying thousands of tourists. Besides, cities now have an added radius of trade territory, ranging in many instances from 100 to 150 miles, made possible by fast-moving automobiles and trucks. These conditions have emphasized the grave mistake of concentrating traffic onto a few roads and in many cases leading it directly through the business section, and the streets of heaviest traffic, in towns and cities. Under our state laws (which are like those in many other states) we are prohibited from making road and street improvements within incorporated cities and therefore are compelled to concentrate traffic onto city streets on which the state can give no assistance. It is practically impossible for many of the cities, with their limited finances, adequately to maintain the streets and handle this traffic.

Quite often the topography surrounding our cities makes it extremely difficult to bypass this traffic outside

the city limits without adding very materially to the distance traveled. Considering that the roads still have the double purpose of serving both the surrounding territory and through travel, any great amount of added

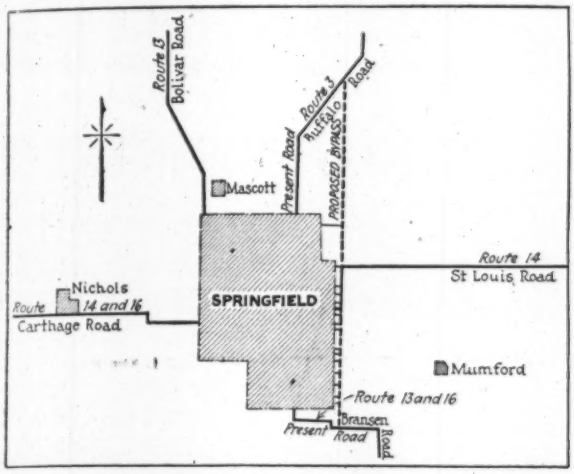


FIG. 1—NORTH AND SOUTH TRAFFIC BYPASSES, SPRINGFIELD

distance placed in a bypass road naturally increases the distance which the local travelers have to cover in reaching their market and business sections. Therefore, extreme care must be used in selecting routes.

We have a proposed bypass road at Springfield on Route 3 (Fig. 1) which will take the traffic out of the city without increasing the distance for local travel. Primary Route 3, which originates at the north boundary of the state and continues south through Chillicothe, Marshall, Sedalia and Springfield to the Arkansas state line, will be called upon to bear a heavy north and south traffic, as it leads to one of the famous playground regions of the Ozarks located south of Springfield in Christian, Stone and Taney counties along the White River and its tributaries. The map shows the proposed bypass skirting the east city limits which will shorten the distance for through travel, and will not increase the distance for local travel using this road from the north and south into Springfield. It will have the additional advantage of connecting with numerous streets, leading east and west through the city, upon which traffic can turn off going to the business section, and will not concentrate all of this traffic, within the city limits, upon any one street.

Fig. 2 shows the proposed belt line around St. Louis. St. Louis, being located upon the eastern side of the state, has four main heavily traveled state roads leading into the city in an arc of approximately 90 deg. The territory immediately adjacent to St. Louis, being made up of numerous towns and communities, is practically as densely populated as the outer section of the city itself and, for traffic purposes, may be considered as one large community of a million population. This condition leads to a heavy traffic from one section of the county to another, which, under present conditions, is compelled to follow one state road into the city and another state road out to the desired destination. By building the proposed belt line, as indicated, this traffic will be served without forcing it through the city and will also give the through traffic a chance to shorten the distance that it would otherwise be compelled to make by going into the city, at the same time lessening the confusion which the stranger usually encounters in getting into and out of a large city.

We are adopting the policy of skirting the towns, wherever possible, with our main trunk roads, if it can be done without adding materially to the traveled distance and without greatly inconveniencing the local traffic. Where this is impossible, we are endeavoring to secure a location through the city which will keep the traffic as far as possible off the main or business streets. An example of this is our main Primary Route 2 connecting St. Louis and Kansas City, a distance of 246 miles, which will pass through only two towns of over a few hundred people. It is necessary to go through these two cities, St. Charles and Boonville, on account of the present Missouri River bridges at these two points. This location has been accomplished without adding to the distance, and in many cases we have been able to secure better alignment and better grades by skirting the cities and towns. The road as located will not vary from a straight line, between St. Charles and Boonville and between Boonville and Kansas City, more than two or two and a half miles and will be shorter by some 35 or 40 miles than any present railroad line which connects the two cities.

When this idea of missing the populous centers was first proposed, there was much dissatisfaction and criticism expressed, especially by local business interest. However, as the roads are being improved and the

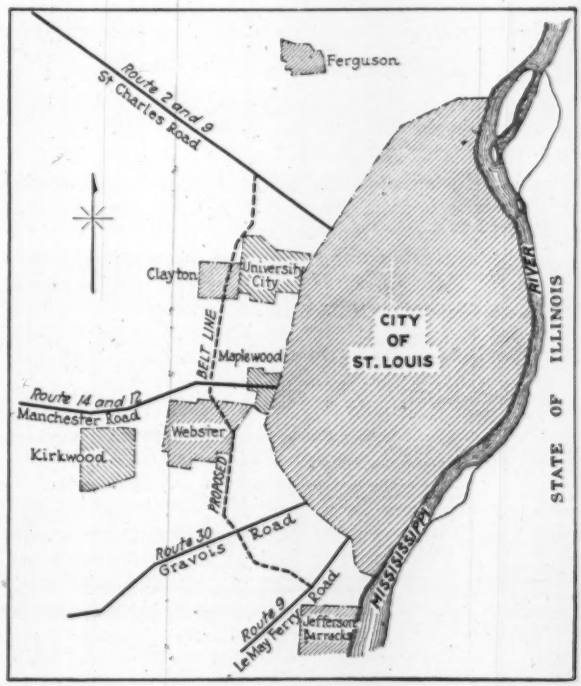


FIG. 2—BELT ROAD CONNECTS RADIAL ROADS INTO ST. LOUIS

traffic becomes greater, the soundness of the policy adopted by the commission, in keeping traffic off the main city streets, is being realized by the local people and the opposition is gradually becoming less.

An Interview
With W. A. VAN DUZER
Equipment and Transport Engineer, Pennsylvania Highway Department

Up-Keep of Road Maintenance Equipment

By C. S. HILL
Associate Editor, Engineering News-Record

Highly Organized Equipment Division in Pennsylvania Keeps 4,000 Equipment Units Costing $4,000,000 in Service—Renews 20 per cent Annually

MAINTENANCE is the continuing business of highway administration. Ultimately in every state there will be a gradual diminution and finally virtual cessation of new road construction. It is not possible to conceive of diminution of maintenance if modern highway transport is to continue. Now the equipment repaired and renewed is the business of the equipment division. Let us consider the procedure as exemplified by a single state.

Pennsylvania has 10,307 miles of state highways about 4,000 miles of which are main traveled roads. All this road is maintained by the state. The road

1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31

DESCRIPTION OF PART | BIN NO. | SIZE | MINIMUM / MAXIMUM | PART NO.

FOR ——— CAR MODEL ——— NUMBER USED IN COMPLETE CAR ———

ON ORDER			RECEIVED AND DELIVERED								RECEIVED AND DELIVERED							
Date	Order No.	Qty.	Date	Dist. No.	Requisition or Purchase Order	Equipment Code	Equipment No.	Unit Price	Qty. Rec'd. or Del.	Balance on hand	Date	Dist. No.	Requisition or Purchase Order	Equipment Code	Equipment No.	Unit Price	Qty. Rec'd. or Del.	Balance on hand

FIG. 1—STOCK RECORD CARD, EQUIPMENT DIVISION, PENNSYLVANIA HIGHWAY DEPARTMENT
Original card is 8x5 in.; face and reverse identical.

Commonwealth of Pennsylvania	Form No. 800 Steam or Gas Equipment Inspection Report (Other than Truck or Automobile) (Original)	Department of Highways

Make of Equipment ——— Kind of Equipment ——— Department No. ———

Assigned to ——— Operator ——— Located on Route No. ———

County ——— Date Inspected ——— Date last Inspected ———

Does this equipment indicate that it has been properly oiled and greased ———

Is there extra oil and grease carried with this equipment ———

Repair Code:—1. O. K. 2. Fair. 3. Repair or adjust. 4. Tighten up. 5. Replace new. 6. Oil 7. Replace oil or grease cups.

Code	Part Inspected	Code	Part Inspected	Code	Part Inspected	Code	Part Inspected
	BOILER		Drain cocks		Track roller		Shafting
	Plues		Throttle		Track roller support bracket		Gears
	Crown sheet		Links		CRUSHER		Pinions
	Stay bolts		Blocks		Roller		Bearings
	Safety plug		Pins		Roller bearings		Cables

FIG. 2—PORTION OF REPORT MADE BY EQUIPMENT INSPECTORS
Original is 8½x11 in. The total list of parts inspected numbers 160 items. On the reverse are instructions. At the bottom are a date and signature line.

division of a state highway department has the task of keeping up the plant for the maintenance business. The task is a large one. In a state highway department, which has from 5,000 to 10,000 miles of state road to maintain, a plant investment of several million dollars in several thousand items of major equipment is not unreasonable. To place the items in their proper positions and to keep all equipment inventoried, inspected, structure is kept in condition, the routes are marked for the security and information of traffic and there is complete snow removal from main-traveled highways. These various operations account for a large variety of equipment besides the variety demanded by the several types of roads. Methods of maintenance and of equipment operation are not the subjects for consideration here. They are those which experience has shown

to give the best condition of roads for the expenditure permitted. Always, let it be noted, the limitation of allowed expenditure has to be kept in mind. It determines the operations of the equipment division as well as the work of maintenance.

Equipment, Tools and Stores—There are over 4,000 items of equipment valued at something over $4,000,000 in charge of the equipment division. Table I gives the items and the number of each as of September, 1924; is one of the improvements to be looked forward to as experience increases and as old equipment is replaced with new. A factor of large influence will be well-kept service records. Such records are being made a prominent part of the equipment division's accounting system in Pennsylvania.

Tools and stores require consideration chiefly in the matter of accounting which includes keeping up the stock. The number and variety—particularly of stores

FIG. 3—SHOP VIEW SHOWING MOTOR REPAIR GROUP

the figures change and generally are constantly increasing. It should not be assumed that the figures show the best or even the desired relative proportions of different machines. They do not. Much of the equipment is surplus war material or is a legacy from past practice. Table I, therefore, represents the equipment as it stands and as it must be dealt with by the equipment division. In this respect all state maintenance equipment departments are in the same category. The fact being advanced is that equipment standardization for the reasons named is in a rather embryonic stage. It

TABLE I—MAJOR ITEMS OF ROAD MAINTENANCE EQUIPMENT OWNED BY THE PENNSYLVANIA DEPARTMENT OF HIGHWAYS

Name	No.	Name	No.
Trucks	757	Steam shovels	6
Oil distributors	24	Spreaders	89
Automobiles	201	Dump carts	34
Road rollers	128	Planers	4
Tractors	159	Sweepers	55
Tractor engines	24	Forges	89
Locomotives	20	Road machines	422
Crushers	47	Rooter flows	74
Engines and boilers	27	Road plows	126
Lineographs	48	Water wagons	12
Cranes	7	Water carts	5
Mowers	24	Flat cars	13
Air drills	53	Clam shells	11
Steam drills	9	Hand cars	4
Sprayer	1	Asphalt kettles	52
Road repair outfit	1	Motorcycles	150
Scarifiers	23	Gasoline pumps	121
Scrapers	26	Steam pumps	6
Dump cars	181	Batch boxes	304
Storage tanks	15	Finishing machines	5
Trailers	4	Bituminous mixers	1
Sheds	74	Fire wagons	2
Surface heaters	4	Truck suspension scales	13
Snow plows	205	Cement gun	1
Concrete mixers	54	Derricks	2
Sprinklers	135	Firing batteries	46
Hoists	10	Unloading outfits	49
Subgraders	5	Dump wagons	219
Total number of items			4,181

which are mostly repair and replacement parts—preclude scheduling to any advantage. Moreover the present stores are very largely surplus war material and are what is available in kind and amounts and not what might be most desired, so any schedule would have little significance. It is only the method of accounting which contains any general lesson.

In Pennsylvania the outstanding feature of stores accounting is the stock-record card shown by Fig. 1. There is a card for each item and each size of each item. The card, it is important to notice, is a definite record of price, stock, receipts and disbursements and is a perpetual inventory. However, a physical inventory is made every three months. A number of other forms, as stores issues, transfer tags, purchase orders and stock reports, enter into stores accounting but the stock record card is the nub of the system.

Similarly in the matter of tools accounting, the tool box is the unit by which all tools are registered and a master record card is kept for each tool box—all accessions, disbursements and transfers are shown by this card. Every quarter a foreman's tool box report is required and annually an inventory and valuation is made and reported to the division head.

Insurance and Accidents—Full insurance of all equipment is absolutely essential. Motor vehicles in particular are covered by fire, public liability and property damage insurance. Fire insurance is required of all equipment and steam boiler insurance of all steam power equipment. A very close accounting of this insurance is required so that adjustments of policies may follow promptly when equipment is added to or

removed from service. Special forms insure correct and prompt reports of accessories and discontinuances to the insurance companies.

Full reports of accidents are equally important—this refers both to department equipment and to other property losses in which department equipment may be involved. Special forms are employed for these reports (1) so that damage adjustments may be prompt and (2) so that personal responsibility, particularly for motor vehicle accidents, may be determined. Annually all accidents are analyzed and summarized to show location, personal responsibility, damages, causes, etc.

Inspection and Inventory—Monthly inspections in general are the basis of undertaking repairs exceeding the minor replacements and adjustments which are the operator's daily routine of keeping his machine in service. Seven inspectors cover the state and report on all major equipment monthly, using special forms; a portion of one form is shown in Fig. 2. This report is the essence of the inspection process; on it is founded all action. In practice the inspector keeps one copy and sends one each to the equipment division, the superintendent, the division engineer and the district engineer. Besides filling in the formal items the inspector is expected to recommend the conditioning necessary and to indicate whether it is a local repair job or one for the headquarters repair shop at Harrisburg. The report also shows whether or not previous recommendations for improving the condition of the equipment have been carried out so that the equipment division may be in position to follow up repairs which are not being made in accordance with the inspector's recommendations. Besides their inspection reports the inspectors report weekly so that headquarters may be informed of their activities. Again, every fifteen days, the employee to whom the recommended repairs are assigned reports progress until the machine is in service.

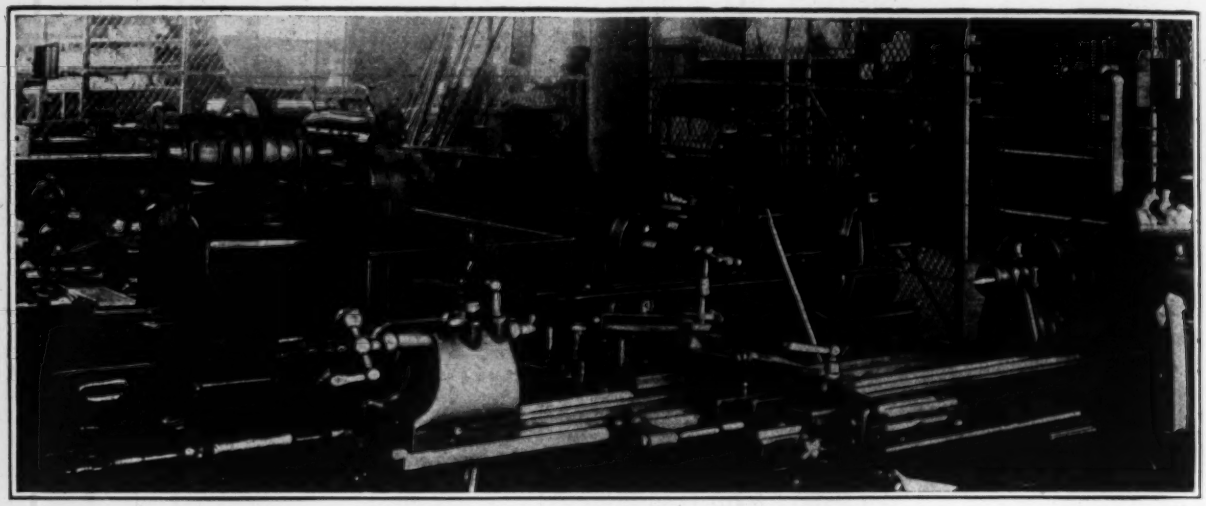


FIG. 4—SECTION OF GENERAL MACHINE SHOP

With the frequent reports of inspection and repairs a fairly close inventory of equipment condition is had at all times. However, on the first of the year an inventory is made showing the location and condition of every piece of equipment, giving its appraisal value and its probable remaining life and recommending its continuance in service or its replacement. If condemnation and replacement are advised for any unit a special report is required which will make clear its life and service and which recommends whether or not replacement should be by the same make and kind of

TABLE II—EQUIPMENT RENTAL SCHEDULE IN PENNSYLVANIA

EQUIPMENT WITHOUT OPERATOR

Dodge	Roadster, with fuel and oil	0.65	Drill, steam	3.25	0.02
				D-44	0.05
Ford	Roadster, with fuel and oil	0.41	Distributor, chip		0.15
			Forges		0.01
Ford	Touring, with fuel and oil	0.42	Heaters, surface		0.06
			Kettle, asphalt	50-150-gal	0.02
				250-gal	0.04
Batteries	15 hole	0.01		400-gal	0.06
	25 hole	0.01	Linograph		0.04
	30 hole	0.01	Machine, road	900 lb	0.10
Box, batch		0.01		2,600 lb	0.20
Buckets, clam-shell		0.14		6,000 lb	0.30
Cars, dump		0.02	Machine, sub-grader		0.16
Cars, hand		0.01	Mixer, concr	5-cu.ft	0.42
Cart, dump		0.01	Motorcycle	Solo machine	0.16
Carts, water		0.05		Sidecar mach.	0.17
Compressor, Drill, Air No. 2		0.07	Planer, road		0.54
			Plows, road		0.01
			Plows, rooter		0.01
	32 cu.ft	0.09	Plows, snow		0.64
	35 cu.ft	0.17		"V" shape	0.04
	8x8	0.53	Pumps, gas and steam		0.04
	100 cu.ft	0.17	Scale		0.47
Crusher and bin (eng. exclud.)	8x14 in.	0.07	Scarifier	4,500 lb	0.10
	Over 8x14 in.	0.10		6,000 lb	0.11
Derricks	30-ft. boom	0.05	Scrapers, road		0.09
	Over 30-ft. boom	0.22	Sprinklers	400 gal	0.07
				450 gal	0.07
				600 gal	0.09
Stone spreader attachment		0.04	Unloading outfit		0.44
Sweeper, street		0.10	Wagon, dump		0.02
Tank, storage		0.01	, fire		0.04
			, water		0.01

EQUIPMENT WITH OPERATOR, FUEL AND OIL

Items of Equipment	Type or Size	Hourly Rental Rate	Items of Equipment	Type or Size	Hourly Rental Rate
Cadillac	Touring	$1.85	Cranes, steam	10-15 ton	1.94
	Sedan	2.08		Over 15-ton	2.36
	Limousine	2.21	Engines, boiler	15-25-hp	0.92
Dodge	Touring	1.26		30-hp	0.99
Franklin	Touring	1.49	, trac.	18-20-hp	1.10
Reo	Touring	1.45		25-hp	1.16
	Coupe	1.56	, hoist	Single drum	1.37
Studebaker	Touring	1.55		Double	1.47
Buick	Touring	1.30		Triple	1.58
Hudson	Roadster	1.56	Gun, cement		4.84
Motor trucks	1-ton	1.38	Locomotive	3-ton	1.37
	1.5-ton	1.49		5-ton	1.64
	2-ton	1.73			
	3-ton	2.02			
	3.5-ton	2.22	Machine, concrete finishing		1.25
	5-ton	2.32	Mixer, concrete	12 cu.ft	0.99
	5.5-ton	2.34		16 cu.ft	1.25
600 gal oil	Distributor	3.45		20 cu.ft	2.24
800 gal. oil	Distributor	4.14		32 cu.ft	3.25
Tractor	2-ton	1.21	Plant, asphalt		3.34
	5-ton	2.11	Rollers		1.47
	10-ton	2.83	Shovel, steam		3.35

FIG. 6—INTERIOR OF STORAGE SHED FOR DEAD TRUCKS

machine. All condemned equipment is promptly sold.

Repairs—The inspectors' reports determine, as has been indicated, whether the equipment undergoes minor repairs—is a service job—or comes to the headquarters shop for a complete overhauling. It is only in case of complete overhauling that the procedure need be reviewed. Briefly the steps are: Request for repairs; approval of request for repairs; order for transfer; inspection preliminary to repairs; order for repairs and notice to the field of the probable time required for repairs. The procedure in the shop is one of considerable detail but of the kind familiar to shop management, namely job cards and tags, job control boards, and progress and completion reports.

The repair shops are at the central garage at Harrisburg. This is a two-story reinforced-concrete building with a floor space of 40,000 sq.ft. The shop is divided into nine sections or repair groups: (1) General assembly group; (2) transmission group; (3) blacksmithing and welding group; (4) brakes and steering group; (5) radiator group; (6) motor group; (7) machine shop; (8) tops, painting and upholstering group, and (9) dynamometer and road testing group. It will be noted that provision for motor vehicle repairs stands out. With something over 1,100 vehicles in service as shown by Table I this is quite natural but there is enough shop plant for any other equipment repair as well. Figures 3 and 4 are repair shop views.

Stores have already been mentioned. However, properly to supply the repair parts there is at the shop a complete stock room having 9,000 small stock bins and also steel racks for larger repair units. This stock room in 1924 was servicing the repairs for nine makes of trucks, Ford automobiles and tractors.

Some notion of the shop activities may be gained from the shop force in 1924: 7 clerks working on office records; 6 chauffeurs to operate the assigned cars from the garage; 13 men at the storage sheds; 16 men in the stock and shipping section, who were engaged in supplying the repair parts to both the shop and the field, and 73 mechanics in the shop.

Storage—Storage under shelter is provided for virtually all equipment and especially for motor vehicles. Besides the garage which gives considerable live truck storage space there are 72 storage sheds of 306,840 sq.ft. Five of these sheds and the garage are at Harrisburg and the others are located about the state in the various maintenance divisions. Other storage space, including land permits for out-of-doors storage, is rented as wanted.

Storage accounting is followed closely (1) as to the location of each piece of equipment and its receipt into and discharge from storage so that insurance may be properly adjusted, (2) as to leases and land permits and (3) as to department storage sheds—location, fixtures and equipment, contents, etc. The equipment

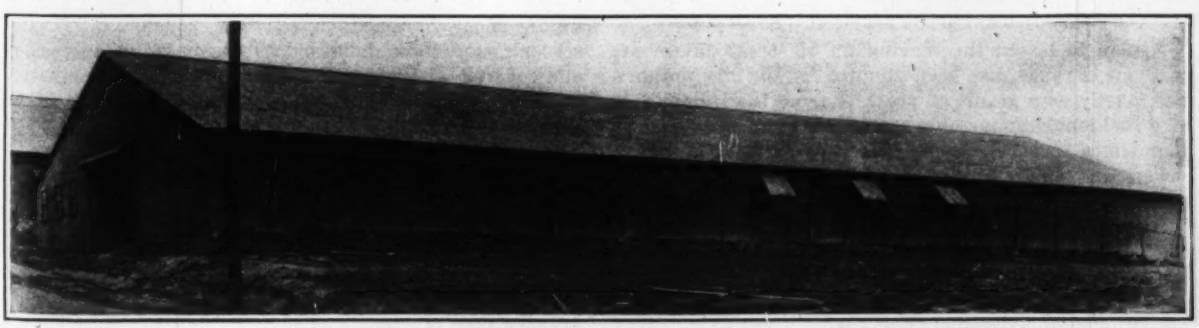


FIG. 5—ONE OF OVER SEVENTY EQUIPMENT STORAGE SHEDS

registration records show the status of each piece of equipment, whether in storage, in repair or in service.

Operation—It is necessary always to remember that inspection, repairs and protection in storage all have the fundamental purpose of keeping equipment in operation. Knowledge of operation or performance is, therefore, essential to any close analysis of the efficiency of the inspection and repairs and other procedures. So important is this consideration that the equipment division has laid down the following directions:

> At the close of each month the equipment division should receive from the various divisions or districts a monthly operating report which shall be prepared for each piece of equipment and shall be in the form of a daily record showing the kind, department number, charge number, route or application number, county, quantity produced, miles covered, ton-miles computed, or hours in service, depending on the kind of equipment. It shall also show date equipment was first received and its condition at that time; condition during week reported and reason for not operating full time if such is the case; information as to whether repairs can or cannot be made locally and action taken in this connection, first day out of service and first day repaired and put in service.

Very complete forms are provided for these reports and the other processes of operation accounting. Chiefly these data are of worth in directing selection of equipment and supplies and of repair methods but they also give summaries of general performance which are of decided interest as, for example, the following for 1923:

Kind of Equipment	No. in Use	Work Performed	Days in Use	Days Under Repair
Trucks	468	7,555,295 ton-miles	60,854	11,863
Rollers	106	135,704 hours	13,452	837
Tractors	128	43,191 hours	4,366	1,049
Mixers	26	6,090 hours	659	43
Crushers	45	179,006 tons	3,762	167
Finishing machines	1	497 hours	52	0
Locomotives	10	3,339 hours	339	34
Cranes	8	2,811 hours	279	0
Traction engines	20	21,278 hours	2,158	61
Steam shovels	8	7,979 hours	763	67
Steam engines	23	14,895 hours	1,596	26

Rental—Equipment used by the maintenance division is charged up in the form of rental. The rates shown by Table II are based on annual depreciation, plus annual shop repairs, plus annual field repairs, plus storage and incidentals. This is, of course, another reason for close operating records.

Closure—Only the high points of the business of handling the equipment division of a state road maintenance department have been touched. It has indeed been the purpose of this talk only to convey the picture of size and importance which equipment purchase and upkeep has assumed. Let us look at Pennsylvania again:

There are over 4,000 major equipment items valued at $4,000,000, of which 20 per cent, or $800,000 worth, has to be replaced each year.

To Lessen Pavement Destruction in Paris

A plan to lessen the tearing up of street pavements in Paris, France, has been adopted by the city authorities, partly as a result of protests from the inhabitants of a fashionable quarter where the streets were dug up four times in succession in one year—to get at water, sewer, gas and electric conduits—after which a new pavement had to be laid. Under the new plan, once in three months the city consulting engineer will call into conference the engineering heads of the various public service. Plan for work projected will be considered and a date for their execution decided upon which will meet the technical demands of each.

Sewage Screening and Composting Plant for New Rochelle, N. Y.

By George W. Fuller
Consulting Engineer, New York City

With the recent award of contracts for a sewage screening and composting plant, a pumping station, connecting and outfall sewers, New Rochelle, N. Y., has brought to a close a 15-year period of discussing sewage disposal betterments.

In 1895 the city installed chemical precipitation works at Morgan St., discharging into shallow water of an arm of Long Island Sound near the foot of Whitewood Ave. and not far from the grounds of the New York Athletic Club. The sewage of the Drake Ave. district, without treatment, has added to the accumulation of sludge in New Rochelle harbor. Twenty years ago a 25-in. outfall was extended about 4,800 ft. into the Sound at Bailey's Rock for discharging by gravity, without treatment, the sewage of the main portion of the city. This line has become overtaxed at high tide. In 1924 the Hudson Park Bathing Beach was ordered closed by the city health authorities and civic organizations clamored against pollution along and near practically the entire water front due to inadequate collecting sewers and the absence of treatment.

Last June, Fuller & McClintock, New York City, recommended: (1) A new 36-in. outfall extending from the city yard adjacent to the Boston Post Road into 25 ft. of water in Long Island Sound about 1,000 ft. beyond Bailey's Rock, terminating in three outlets; (2) a fine screening plant to be located at the city yard in a combined pumping station and screening building, with the screenings to be composted in an adjacent building; (3) a pumping station at the foot of Whitewood Ave. to deliver sewage from the area tributary to the original disposal plant; (4) a line of connecting sewers along the water front into which the Whitewood Ave. pumping station, and also the Drake Ave. gravity outlet would discharge. On Nov. 28 Commissioner John A. Hadert received bids on the work outlined, divided into four contracts. Since then contracts for the work totaling $621,264 have been awarded. [For prices and contractors see Construction News Section for Dec. 18, p. 322.—Editor.]

The treatment works will provide for screening through two 8x8-ft. Dorrco screens of 10 m.g.d. nominal capacity each.

An unusual feature of this plant is found in the method of disposal of the screenings. These are to be delivered directly from the screens to ejectors and by compressed air blown to an adjacent covered compost building, the substructure of which is divided into eight units, of a combined capacity of 22,000 cu.ft. The screenings will be delivered to the units in succession and covered with about 8 in. of earth as often as necessary, depending greatly on the season of the year, to prevent the breeding of flies. Later this material, composed of the layers of earth and decomposed screenings, will be disposed of on unused city property or barged to sea. The contract price for screening, pumping and compost plants and the housing of these is $178,640.

New Rochelle has a present population of about 40,000 and the sewers are on the separate system, with an average flow of about 5 m.g. daily.

Hazards and Safeguards of Highway Structure

Chief Danger Points: Width, Car Tracks, Curves, Parking Space, Cross-Section, Guard Rails, Clear View, Bridges, Intersections, Crossings, Detours, Snow, Signs, Lighting—Precautions Against Hazards

ONLY a very small percentage of the street and highway accidents today can be attributed directly to construction and enginering defects. Nevertheless, so rapid has been the development of motor traffic and so rapid will its future growth unquestionably be, that the subject of safeguarding the highways must be considered in anticipation of a much greater volume and density of traffic than now exists on most of the highways, of larger and heavier units, and possibly of higher allowable speeds.

Highway Widths—The roadway of every rural highway worth improving should be so wide that two vehicles can pass without going off the pavement and without retarding speed. In open country well away from the large cities two lanes will probably in most cases carry all of the traffic safely, and where they will not it is preferable in the interests of both safety and capacity to build or improve a new two-lane highway parallel to and at no great distance from the first, rather than widen the first.

In suburban or metropolitan areas, for distances in some cases of 50 or 75 miles from the large cities, the travel on many of the highways will warrant wider roadways. If the traffic is balanced as well as heavy there should be four lanes, or two two-lane roadways side by side. Three-lane roadways are effective and economical, however, where there is a great preponderance of traffic in one direction at all times or in one direction part of the day and in the other at other times. In such cases the preponderating traffic will automatically determine the direction of flow in the middle lane. This applies primarily to highways leading into large cities and carrying a large number of persons daily to and from their places of business.

In city streets the minimum pavement should accommodate three lines of traffic, so that an occasional motor vehicle parked parallel to the curb will not narrow the roadway down to one line. Streets carrying a double-track car line should have a minimum paved width sufficient for a line of vehicles on each side of the tracks. Streets of heavy traffic will naturally require greater widths; generally an even number of lanes of traffic is preferable, to avoid conflict of movement.

The roadway width in city streets should always be a multiple of the standard lane. A lesser width is unsafe; a greater width is uneconomical. Existing streets not so designated may sometimes be made to carry an additional line of traffic by slightly widening the roadway. The possibility of future development of a residence street into a street car or business street should be borne in mind and the trees and sidewalks placed accordingly, so as to facilitate future widening of the roadway.

No improved rural roadway should be narrower than 18 ft. to provide two traffic lanes as recommended. While the 18-ft. roadway will permit ordinary automobiles and motor trucks to pass safely without reducing speed, it is insufficient for the newly developed de luxe bus, which has a wide spread of the rear wheels. To enable such buses to pass other vehicles safely at high speed would require a 24-ft. roadway. Whether this extra width should be provided at public expense to accommodate a relatively small number of vehicles operated for hire is an economic question outside of the province of this report. Safety requires, however, that the speed of such buses operating on highways less than 24 ft. wide be severely restricted while passing other vehicles and that they be prohibited entirely from operating on highways less than 18 ft. wide.

Furthermore, plans are being developed for a new type of bus with six wheels and an overall length of some 75 feet. Such buses in addition to requiring a wide lane, will be unable to round the curves on some improved highways without crowding off vehicles they may meet. Therefore, no carrier for hire should be granted a permit to operate on any section of highway unless the vehicle it contemplates operating can pass over every section of the highway without encroaching upon the lane of traffic in the opposite direction.

The rapid growth of traffic that has followed the improvement of most highways points clearly to the necessity for anticipating future requirements and providing additional right-of-way before the cost becomes prohibitive for future widening as well as for providing parking spaces, protecting the view of the motorist and other purposes, the importance of which is pointed out in other sections of this report. For the same reasons additional right-of-way should be acquired at once along highways already improved where there is reason to believe that it will ultimately become a necessity.

Undoubtedly the most complete discussion ever given of the function of highway structure in safeguarding highway traffic is contained in the report of the Committee on Construction and Engineering presented last month to the National Conference on Street and Highway Safety. The report is, therefore, printed here with only little abbreviation. The illustrations are not a part of the committee report but have been selected from the files of the editor to indicate outstanding practices discussed in the report.—*Editor.*

Street Car Tracks—For wide principal streets and highways well outside of the congested or strictly business areas of the city accommodating both street-railway and vehicular traffic the public is best served by a physical separation of these two classes of traffic. A reservation in the center of the street should be provided for the exclusive use of the street railway, with a one-way driveway on each side for other vehicular traffic. This permits faster and safer operation of the street cars and gives opportunity for safe landing platforms for the passengers; and where such landing platforms are provided the motor vehicles are afforded safer and more rapid passage, inasmuch as they are relieved of the necessity of stopping behind street cars standing to discharge or receive passengers.

Street car lines running at the side of rural highways frequently cross and recross the roadway repeatedly. Aside from the danger to motorists arising from the sudden and unexpected turning of street cars into the roadway, these repeated crossings are dangerous because they may, particularly at night, mislead motorists into turning off the roadway into the ditch. The tracks or roadway in every case where possible should be relocated so that the tracks will remain continuously on one side of the roadway.

Parking Space—The Committee on Traffic Control will recommend that vehicles be prohibited from parking or stopping on the traveled portion of any improved rural highway. A corollary to this recommendation is that there must be adequate space off the traveled way where motorists can park or stop safely. It is not necessary or desirable that these spaces be of the same material of which the road is constructed, but they should be sufficiently stable and level to support the vehicle at any time. They already exist naturally along many highways, but where they do not they should be provided as a part of the construction of the road, at intervals not to exceed 300 ft.

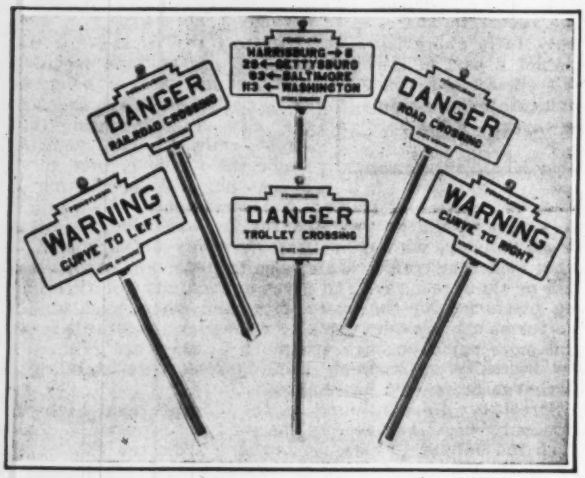
Grades—A general standard maximum grade of 6 per cent should be established for thoroughfares of primary importance, both in rural districts and in cities and towns, particularly for those thoroughfares in cities and towns which form part of the general highway system. Topographic and economic conditions, however, often make it impracticable to hold to such a maximum grade. In highly developed country, particularly in the East, grades on existing highways greatly exceed this, and to keep to a rigid maximum of 6 per cent in the reconstruction of such a road or street would entail heavy property damage. In certain mountain country, also, a 6 per cent maximum is difficult to attain. However, a location can almost invariably be found with grades not higher than 9 per cent,

and nothing steeper should be permitted on any highway or street of primary importance.

On rural highways of secondary importance, where it is necessary to hold the construction cost down in order to develop as much highway mileage as possible, 10 per cent grades may be permitted. In purely local residential developments in cities 12 per cent grades may be used to avoid unduly hampering property development. They should not be introduced where they are likely to carry any appreciable amount of through traffic. Grades as steep as 20 per cent exist in the built-up sections of some cities, and cannot well be eliminated. No new street, however, should be laid out with such grades.

Curves—No curve on a highway of primary importance, or on an important park drive, should have a radius less than 300 ft. Even this radius should be permitted only when a clear view ahead of 300 ft. is available from all points on the curve, including the inside traffic lane, and where this is not attainable the curve should be flattened or relocated.

The present-day high-speed motor highway is comparable to the railroad, and railroad practices in the treatment of curves can well be followed in highway design at curves. The curves should be super-elevated on the outer rim and provided with transition curves at the ends, and heavy grades should be compensated for curvature. Exact calculation of such compensation is not necessary, but a combination of heavy grade and sharp curve should be avoided.



PENNSYLVANIA DANGER AND WARNING SIGNS

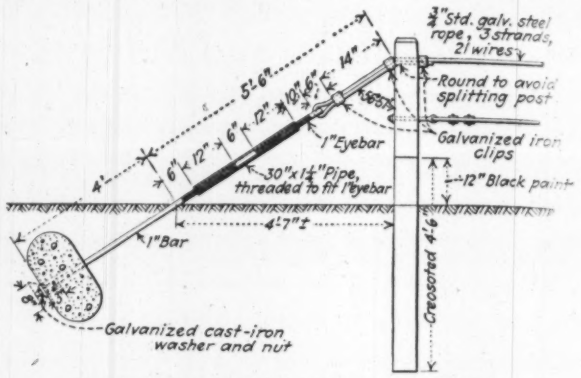
All traffic safety signs in Pennsylvania are erected on their own posts and all are metal. Attaching signs to transmission line poles or other structures is forbidden.

Roadway Cross-Section—Excessive center or crown in pavements and roadways is dangerous, especially in wet weather. Depending on the character of the pavement and also on the running grade of the street or highway, the cross-section of the pavement should be as flat as drainage conditions will permit.

On some of the older highways the crown was carried around the curves as well as on the straight sections. Such curves are dangerous for high-speed operation, and should be immediately reconstructed with the pavement sloping uniformly downward from the outer to the inner rim of the curve. Curves should also be widened to facilitate passing of other vehicles.

Guard Rails—Highways on embankments should be protected by substantial guard rails. In the mountains and on steep grades the ordinary type of guard rail is not sufficient protection. Where space permits, the outside of all curves where the slope downward from the roadway is considerable should be protected by a substantial earth bank not less than 3 ft. high. There usually will not be room for this where the highway is cut into the face of a rock cliff, but in such cases there should be a substantial stone wall.

Clear View—A motorist on a highway of primary importance should always be able to see an approaching vehicle for a distance of at least 300 ft. This applies on curves, at and approaching hillcrests, and approaching highway intersections. Obscure highway intersections are particularly dangerous, and besides being conspicuously marked with cautionary signs should have the view so cleared if possible that a vehicle approaching the crossing from any direction may be seen in ample time to avoid a collision.



PENNSYLVANIA WIRE ROPE GUARD RAIL

This design was adopted after an extended series of collision tests by motor trucks with all of the common forms of guard rail and with several commercial forms proposed for adoption.

To provide a clear view at all points it will often be necessary to cut down hillcrests, remove trees, shrubs and other obstructions on the highway right-of-way, and level down the slopes of cuts to the height of the eye of the motorist. To supplement this, restrictions should be placed on the use of abutting property. The national associations of outdoor advertisers recognize the importance of a clear view, and properly recommend that no advertising signs be placed where they will interfere with such view.

At intersections in streets it is equally important that a clear view be provided for as great a distance as possible. This is difficult when stores or other structures are built close up to the corners. Considerations of safety may ultimately require a setting back of buildings at such corners.

Highway Intersections—Apart from the necessity in the interests of safety of providing as unobstructed a view as possible at all street and highway intersections, and of marking them conspicuously, many intersections call for careful study, from the viewpoints of both the traffic and the topography, to alleviate elements of danger.

At rural intersections where the preponderating traffic makes a turn it may be well to acquire right-of-way for a flat curve. Before doing this, however, consideration should be given to the possibility that it may introduce new junctions and cross currents of traffic more serious than previously existed. When there is heavy traffic on each of the roads coming to the intersection, with a considerable amount of turning, the introduction of a circle may be an effective safety measure. At some of the busiest intersections separation of grades will appear to be the correct solution.

Intersections of streets on heavy grades call for careful study to make all possible movements as safe as practicable. The running grade of each intersection street should be maintained if possible; the running grades of main arteries of traffic should always be maintained.

Curbs of too short radius force motor vehicles in turning corners out of their proper lane of traffic, thus fouling other lanes. Safety requires that curbs be given sufficient radii to permit the average vehicle to stay in its proper lane while rounding the corner at a rate of speed reasonable for that intersection. This generally means a radius of not less than 15 ft. Larger radii up to 20 ft. may be used in special cases, while at acute angles there should generally be a minimum of 10 ft.

Curbs should not ordinarily, however, have greater radii than sufficient to permit the average vehicle to follow them at a reasonable speed, for the reason that they increase the distance the pedestrian must travel to cross the street in line with the sidewalk, or force him farther back into the block to find the narrowest point.

Buttons or other fixed signals should not be placed in narrow intersections where they can be rounded only by interfering with other lanes of traffic, and traffic officers at narrow intersections should not require motor vehicles to pass around them.

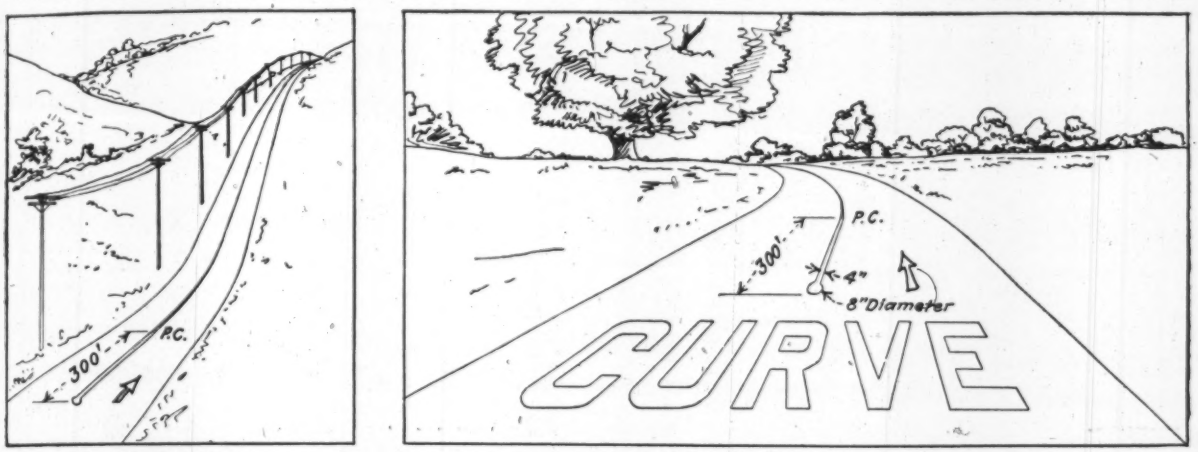
Railroad Grade Crossings—More than 10 per cent of our street and highway fatalities occur at railroad-highway

grade crossings. Elimination of the grade crossing is believed to be the only perfect solution of the problem. This does not mean that within the next generation every grade crossing of secondary highway and branch line railroad needs be eliminated, but it does mean that municipalities, states and railroads should join in an energetic campaign to carry elimination work forward as rapidly as funds obtainable will permit, with an equitable distribution of the expense. Each municipality, county and state should be at work on comprehensive programs for the elimination of its grade crossings, and should be taking steps to provide its share of the necessary funds. At the same time it should be realized that to eliminate even the grade crossings on improved highways and streets (and there are many dangerous crossings on unimproved highways which should be eliminated) would require a greater expenditure than is possible for many years to come, and that therefore the work should proceed on state-wide programs which begin with the highways where a given sum will accomplish the most

usually determine whether the street or highway shall be carried over or under the railroad. From the safety point of view, overcrossings are usually preferable to undercrossings, inasmuch as they are likely to afford motorists a better view and do not need to be obstructed by center columns or curbs.

Many grade separations, particularly underpasses, on what are now improved highways were made before the advent of the high-speed motor car, and are dangerous because of sharp blind curves at the approaches thereto, narrow side clearance, and low head room at the sides in the case of arches. These danger spots should be eliminated by whatever reconstruction is necessary to provide ample view and clearance.

Many more new grade crossings are being opened yearly than are at present being eliminated. New railroads or branch lines should, as far as possible, be required to avoid establishing additional grade crossings, and municipalities opening new streets across railroads should realize that



OHIO STANDARD PAVEMENT MARKINGS ON CURVES

The prominent "curve" sign and traffic direction arrow are notable. Vertical curves are marked with traffic lines even more carefully than are horizontal curves.

in the interest of safety. In general the extra hazardous crossings—extra hazardous because of heavy motor travel, heavy rail travel, obscure view or other conditions—should be eliminated first, although there should be included certain other less hazardous crossings because they can be eliminated for very small sums of money.

Any method of safeguarding grade crossings other than elimination means delay for traffic and consequent inefficiency whereas elimination means increased efficiency for both the railroad and the highway.

The Interstate Commerce Commission has for some time had under consideration requiring the railroads to install automatic train-control devices. Your committee is thoroughly in accord with anything which tends to save human life, but is convinced that the automatic train-control could not save as many lives as could an equal expenditure on grade-crossing elimination. The Summary of Accidents issued by the Interstate Commerce Commission indicates that there were 134 fatalities due to train collisions in 1923, while there were 2,268 fatalities at grade crossings. If the funds required for automatic train control are applied instead as the railroads' share of grade-crossing elimination, and the public contributes an equal amount, as it presumably will, the combined sum will go a long way toward removing the most dangerous grade crossings on our main highways.

Careful study will be required to determine the method of grade-crossing elimination, whether by separation of grades on the present or approximate location of the street or highway, by relocation of the highway where it crosses and recrosses the same railroad, or by consolidation of adjacent crossings. Even diversion of one highway into another remaining at grade may be very desirable to make it possible to give better protection at one crossing and also to divert traffic that would otherwise cross the railroad on one highway and back on the other.

Comparative costs, including property damage, will even though the traffic expected in the near future would not warrant the expense of grade separation they are creating a new problem to require solution ultimately.

Before adopting plans for improvement of highways on which there are numerous railroad grade crossings or other sources of danger, the state and federal highway authorities should give careful consideration to the possible substitution of some parallel route which is free from such difficulties, even if this parallel route is little traveled at present. This proposal naturally applies primarily to highways that are expected to carry a heavy through traffic rather than to secondary highways needed to connect farms with markets.

Crossings remaining at grade should be safeguarded in every reasonable way. A cautionary signal should be placed about 300 ft. from the crossing and this is being supplemented effectively in a number of states by a series of transverse markings. These indications should be further supplemented by whatever protection the traffic and visibility conditions warrant. At crossings where the expense of flagmen or gates is not warranted, automatic wigwag signals are recommended, and to be effective at night such signals should carry a red light. They should be kept scrupulously in order. At crossings where there is frequent train movement as well as heavy motor traffic there should be a flagman or crossing gates. Gatemen and flagmen should be mentally competent and physically able to perform their duties properly. For the busiest intersections there should at all times be a watchman or gateman on duty, otherwise there should be adequate signs so that motorists will not depend on the flagman or gateman.

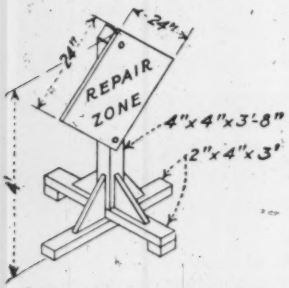
Transverse ridges in the road, zigzag turns and various other expedients designed to force the motorist to reduce speed at railroad crossings have proved ineffective and are not recommended. On the contrary, the operation of the motor vehicle, particularly on and in the immediate vicinity of the tracks, should be made as simple and easy as possible so that the operator can apply himself to watching for

approaching trains. Very much can be done along these lines for a relatively small expenditure, and the dangers of many crossings can thereby be greatly reduced. Frequently where the railroad is on an embankment the highway is carried up to the level of the tracks by a short steep grade which breaks sharply at the track itself, causing danger of stalling. Such approaches should be extended and provided with easy vertical curves or level places so that the motorist can stop and hold his car easily within 10 ft. of the railroad if he discovers a train coming. Short sharp descents to the tracks should likewise be cut away to easier grades to lessen the likelihood of motorists being unable to stop near the tracks, or of being rammed from behind and driven upon the tracks.

Where the crossings are planked, the planking should be maintained in good condition, firm and with a smooth surface. At many crossings driving across at anything other than a very low speed invites a broken spring, while at the low speed there is danger of stalling. Of the many motor cars struck at crossings because the engine stalled, a considerable percentage might have escaped if the crossings had been smooth.

Approaches to crossings should be relocated where necessary to eliminate sharp curves and junctions with other highways close to the tracks. Trees, shrubs, faces of cuts and all other obstructions to clear view along the tracks in both directions for as great a distance as possible should be removed from the highway and railroad rights-of-way. Railroad stations and other buildings should not be located close to highway grade crossings. Cars should not be spotted on side tracks where they will interfere with the view of motorists; if necessary to avoid this, team or industry tracks should be relocated. Effort should be made to persuade abutting property owners not to obstruct the view either with trees or buildings or with less permanent obstructions. Standing corn has contributed to many accidents.

Bridges—All bridges or improved highways should be wide enough for two vehicles to pass safely, without danger of striking the curbing or bridge superstructure. This calls for a minimum width of 22 ft. and de luxe buses operating on bridges of this minimum width should be subject to the same speed restrictions as on 18-ft. roads. One-way bridges are dangerous, particularly short culverts approached in each direction by steep curved descending grades, and they should be replaced by wider structures. On long bridges suitable provision should be made for the safety of pedestrians. Where the expense of a continuous sidewalk is not warranted there should be frequent safety zones, built outward from the face of the bridge so as not to narrow the roadway.

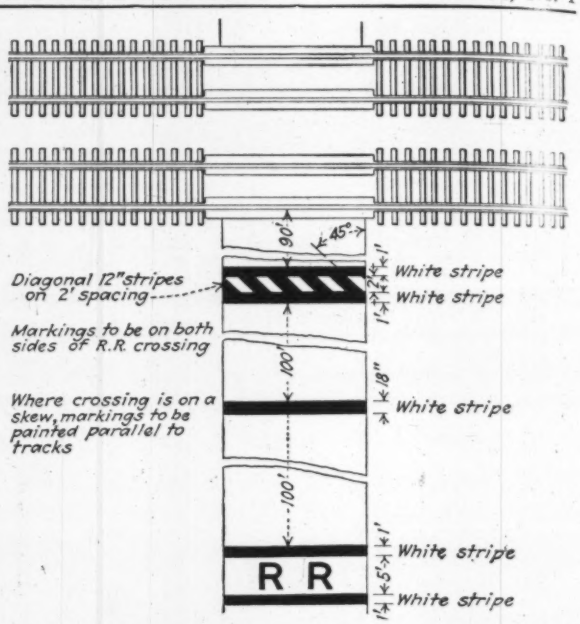


PORTABLE REPAIR ZONE SIGN USED IN OHIO

Detours—Where used, detours should be safe and reasonably satisfactory to operate on, even though this necessitates a certain amount of preliminary reconstruction and maintenance. In selecting them excessive grades and curves should be avoided as far as possible, and also roads likely to be very slippery in wet weather. Particular care should be exercised in the selection of detours from highways in the vicinity of large cities likely to be very slippery in wet weather. Particular care should be exercised in the selection of detours from highways in the vicinity of large cities to carry continuous streams of heavy traffic.

Local residents must be accommodated while roads are under construction, and this calls for either the maintenance of a part of the road in passable condition or short detours around the immediate construction. To take care of the through traffic, however, the highway authorities should go back far enough in each direction, possibly to the nearest large town, to find a good alternate route, and should post this route conspicuously so that through traffic will follow it.

All detours, whether long or short, should be clearly marked. This applies to city streets as well as to rural communities. Streets and highways made impassable or unsafe by construction work should be carefully blockaded with signs and lights. Detour signs should be inspected daily to ascertain that they are in proper condition, and should be promptly removed when no longer required.



NEW YORK PAVEMENT MARKING AT RAILWAY CROSSINGS

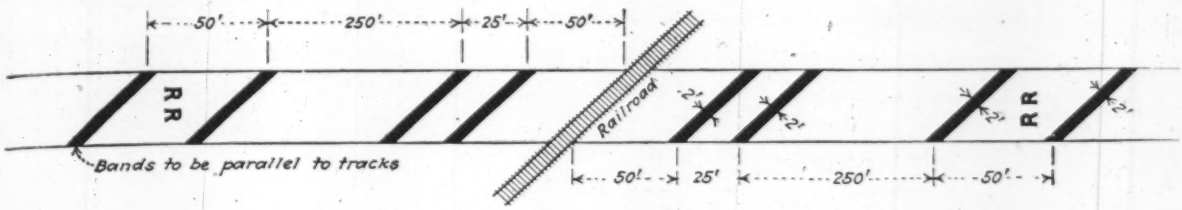
Three separate indications, each different, are given in a distance of 290 ft. from the nearest track rail.

Maintenance and Snow Removal—Safety requires that pavements be maintained in good condition, free from holes and depressions, which besides causing breakage are likely to interfere with drivers' control and with the free flow of traffic. This applies to both city streets and rural highways.

The shoulders of rural highways should also be maintained in suitable condition. Where the shoulder is broken off in an irregular form, particularly if the highway is narrower than desirable, there is danger in meeting other vehicles. This is true even where the pavement itself is in perfect condition, if the earth shoulder is not maintained level with the pavement. A case in point is the concrete highway with a vertical drop of four to eight inches at the edge.

The constant opening of pavements, particularly on busy thoroughfares, constitutes an annoying situation which, notwithstanding all precautions which can be taken seems to be unavoidable. When the city has a properly equipped maintenance force all openings should be repaved by the city forces. If this restoration work is left to the permittee it is difficult to control and bound to result in delay. Openings in the pavement are frequently left unpaved after refilling for a period of weeks to allow the ground to settle. Where there is any considerable vehicular traffic these openings should be covered at once by a temporary pavement, such as bituminous macadam, to be replaced by a permanent pavement when the settlement has ceased.

An important element of street and highway maintenance is snow removal. The motor vehicle has come to be an important agency of transportation the year around, and it must be safeguarded under all conditions and at all times. On rural highways, if the snow is not removed, even chains will not prevent skidding under certain conditions of snow and ice, and getting out of the ruts to pass other vehicles may be hazardous. Both safety and the demands of commerce and industry require that the snow be removed from every main highway and every highway carrying more than 300 vehicles per day. While the cost may seem high, comparison with the cost of repairing the damage done by permitting the snow to remain on the road surface, with the attendant running in ruts of heavy motor vehicles equipped with chains, will show that the net cost of snow removal is less.



OHIO PAVEMENT MARKING AT RAILWAY CROSSINGS

The first indication is 375 ft. from the nearest track rail and it is repeated three times.

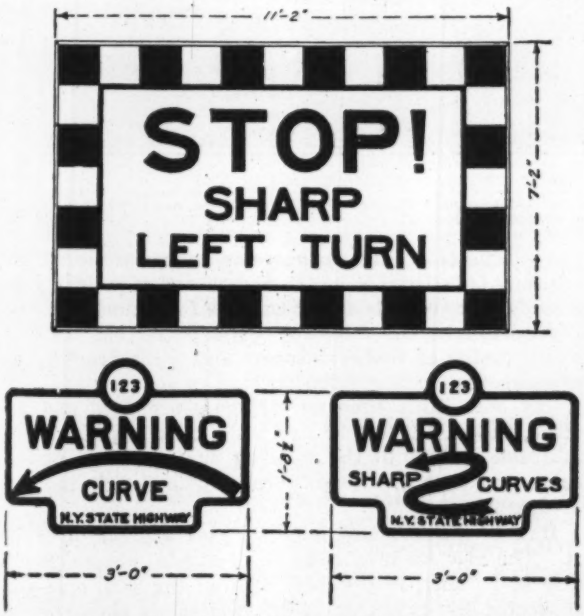
Signs and Signals—Proper signs and signals are essential to the safe movement of traffic on any street or highway. They should, therefore, be erected when the same is opened or improved and the cost should be included as an item of the construction cost. This applies to three classes of signs:

Cross roads, which more definitely affect other vehicles than do curves, grades and other points where caution is required, merit a distinctive color rather than yellow. The recommendation, however, does not conflict with the placing of a yellow sign at cross roads if individual state departments deem that preferable.

Besides highway intersections, the principal danger points on the highway calling for cautionary signs include sharp curves, steep descending grades and narrow bridges or places in the roadway. These should be conspicuously marked with yellow cautionary signs which warn not only of the danger but of the specific kind of danger. The through-traffic highway protected with boulevard stops calls for a red sign to indicate the requirement of a full stop before entering or crossing such a highway. Railroad crossings require special protection.

While the federal-aid, state and county systems of improved highways will perhaps ultimately embrace all highways carrying much traffic, there are at present many unimproved highways with good natural surfaces which carry a considerable amount of travel, and over large parts of which high speeds can safely be maintained. Such highways may lead suddenly to dangerously steep descending grades, sharp curves or rough spots. Where these dangers are not marked by the public authorities automobile clubs or other agencies can perform a useful service by placing signs at the chief danger points on such highways.

No road can be considered satisfactorily equipped with signs unless it has direction and distance signs containing sufficient information in legible form to permit a traveler to go anywhere he desires without the aid of maps or keys. To this end black and white signboards of adequate size should be placed at every cross road and junction, setting forth clearly the information as to direction and distance.



NEW YORK STANDARD WARNING SIGNS

Pavement Markings—The committee has considered carefully the extent to which white center lines should be marked on rural highways and streets. It believes that the white center line should be confined to those points where it is unsafe and in a number of states illegal to be on the left-hand side of the road; namely, on curves, at and near hillcrests, at irregular intersections, at railroad crossings and possibly at a few other points. If confined to those points the white line acts as a positive warning to motorists not to cross it or be on the wrong side of it. The warning effect is lost if the line is used on straight sections and therefore should not be so used. Black center lines, however, whether construction joints in the case of concrete highways built in two longitudinal sections, or lines painted on pavements of a character that will permit it, are effective as a guide in night driving and at all times in keeping each driver on his own side of the road when passing another car, and are recommended as not conflicting with the use of the white line.

Two-lane rural highways, therefore, should be marked with a white center line on curves at and near hillcrests and at irregular intersections but not on straight level sections, except at highway or railroad crossings. The lanes of wider highways and of city streets should be similarly indicated by one or more longitudinal white lines at similar points.

Transverse pavement markings are desirable to supplement the work of signs. Pedestrian lanes should be marked across the pavement at busy intersections. The use of transverse markings in the vicinity of railroad crossings has already been indicated. They can also be used effectively to caution or instruct drivers approaching intersections or other hazards. Parallel lines to indicate individual parking spaces economize the total space where oblique parking is used.

Illumination—Glaring headlights are a danger of the highway for which no complete remedy has as yet been found. The ideal remedy would be such illumination of streets and highways that bright headlights would be unnecessary. This is in general feasible in city streets, and the following amounts of illumination are stated by competent illuminating engineers to be the minimum desirable:

Class of street	Distance between lighting standards Ft.	Number of lamp lumens per foot of street
Business streets	50-75	100-150
Main thoroughfares	50-75	80-125
Residential streets	50-75	50-75

Flood lighting of traffic officers is also recommended.

In rural districts the amount of money required to install and maintain illumination on even those thoroughfares carrying heavy night traffic would be enough to improve and maintain a large amount of additional highway. Taking into account the fact that even though the principal highways were illuminated, most motor vehicles have to operate also on unlighted highways and would therefore have to be equipped with adequate headlights, the committee believes that in general it is more important to provide the greatest mileage possible of improved roads than to light the principal thoroughfares now existing.

Certain highways connecting communities close together have become in effect city streets and should be illuminated. The problem here, however, is one of complete illumination and is distinguished from what is commonly called highway illumination, which is designed solely to serve the user of the roadway.

Anything adjacent to the street or highway which can

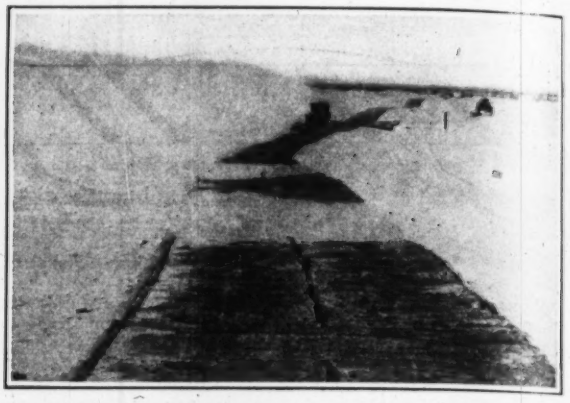
be utilized to reflect light will be of assistance in night driving. Curves, tree-trunks, telephone and trolley poles, sidewalks, fences and especially board fences erected at dangerous curves and at dead-end streets, if painted white or light in color, will be found effective.

Where parking is permitted at night—and it is frequently permitted at night in sections where it is not permitted in the daytime—the design of the illumination is important. This is especially true on narrow streets, where lamps mounted low may cause deep shadows of parked machines out into the center of the street, destroying the effectiveness of the illumination.

Timber Road of Portable Sections Laid on California Desert

Hook and Eye Fastenings Between 6-ft. Sections Permit Easy Maintenance—Experimental Section Replaces Plank Road

FINE-GRAINED sand on the desert in southeastern California near Yuma, Ariz., is so easily moved by the winds and so readily banked up in high drifts that the maintaining of the transcontinental highway through this region has long been a problem to the California Highway Commission. In 1916 for a length of six miles through the dunes a plank road, laid in 12-ft. sections, was put down as an experiment, the idea being that when advancing dunes menaced portions of this planking the sections could be taken up and moved or, if buried too deeply, could be abandoned without much loss and a stretch of new planking substituted. A detailed description of this experimental road, then in process of construction, was published in *Engineering Record*, July 29, 1916, p. 131. The difficulty in maintaining the plank road has been in preventing its complete burial by the shifting dunes during windstorms. Often the road has been completely obliterated until teams and fresnos have cleared away the sand.



PRESENT CONDITION OF 4-IN. PLANK ROAD OF 1916
This road only 8 ft. wide and now rapidly going to pieces has frequently been entirely buried for considerable lengths under large drifts which have to be scraped off with fresnos.

After eight years of travel the 4-in. planks of the old roadway are rapidly deteriorating, the pine timbers are weakened from dry rot, and in many places constant maintenance is necessary. Although the design of the old plank sections has not proved to be ideal, in general the scheme of a light and more-or-less-moveable timber roadway is believed to be the best means of maintaining a surface across this desert suitable for automobile use.

SAND HILLS IN CALIFORNIA NEAR MEXICAN BORDER
The main transcontinental highway from southern California which passes through 6 miles of these sand dunes offers a serious maintenance problem.

Accordingly, the Highway Commission has adopted a new design of timber roadway and is constructing an experimental section 2,000 ft. long to see how the plan works out. This time no stringers are used and instead, 6x8-in. timbers or ties, well bolted together, give desirable weight to the wearing surface itself at the same time that the design permits of a certain amount of flexibility.

Half of the test unit is 18 ft. wide and the other 10 ft. The new roadway consists of 6x8-in. planks, 10 ft. and 18 ft. long, respectively, laid on the 8-in. side and separated by 4x6-in. x 24-in. spacers so placed as to form a track and continuous path for vehicles. The

BUILDING THE 18-FT. SECTION OF THE NEW ROADWAY

Timbers are cut to size and bored for bolting together before delivery. Spacers are spiked to the ties just before they are bolted in place.

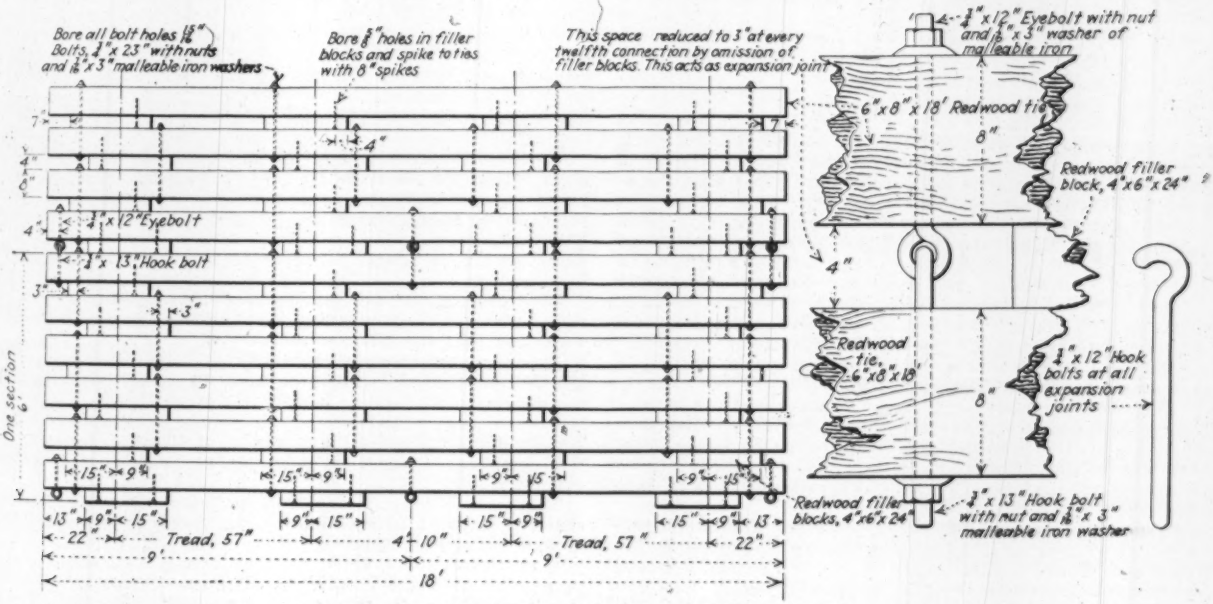
planks are held together by bolts, the unique feature of the design being the arrangement of the bolts so as to hold the planks firmly together and yet permit sufficient elasticity not to unduly strain the structure by possible expansion and contraction during periods of extreme heat on the desert. The 18-ft. road is built in sections 6 ft. long to facilitate maintenance when it becomes necessary to replace worn planks. These sections are fastened together by means of hooks and eyes so that any section may be removed and replaced independently of the rest of the road.

The 10-ft. road is built in sections 8 ft. long. In deciding upon the length of the sections, consideration had to be given to their weight and unwieldiness. After storms, a truck with a crane is able to elevate sections of the roadway, the sand then being sifted through the openings between the timbers and the track lowered again to its proper place.

The present road is but 8 ft. wide and consists of planks bolted and spiked to stringers and held in place by bands of strap iron. As there are no openings between the planks the sand drifts have to be removed with scrapers. Timbers have been weakened from dry rot in many places and constant maintenance has been necessary. Redwood with its vastly superior lasting qualities, is believed the solution unless some means other than a plank road is found for crossing the dunes.

Using redwood timber which has a very long life and in view of expected lower maintenance cost, it is believed that the new roadway will be a decided improvement over the design used in 1916.

R. M. Morton is chief engineer of the California State Highway Commission; E. Q. Sullivan, division engineer at San Bernardino, is in charge of work in the Imperial Valley, and T. R. Goodwin is resident engineer on the timber road construction.


Bore all bolt holes 15/16"
Bolts, 3/4" x 23" with nuts and 1/16" x 3" malleable iron washers
Bore 7/8" holes in filler blocks and spike to ties with 8" spikes
This space reduced to 3" at every twelfth connection by omission of filler blocks. This acts as expansion joint
3/4" x 12" Eyebolt with nut and 1/16" x 3" washer of malleable iron
6" x 8" x 18' Redwood tie
Redwood filler block, 4" x 6" x 24"
3/4" x 12" Eyebolt
3/4" x 13" Hook bolt
Redwood tie, 6" x 8" x 18'
3/4" x 12" Hook bolts at all expansion joints
Redwood filler blocks, 4" x 6" x 24"
3/4" x 13" Hook bolt with nut and 1/16" x 3" malleable iron washer
One section
Tread, 57"
4' 10"
Tread, 57"
9'
9'
18'

DETAILS OF TIMBER ROADWAY ACROSS DESERT

Engineer Board Reports on Chicago Drainage Canal

Epitomized Statement of Conclusions of Board of 28 Engineers on Chicago Sewage Disposal by Diversion from Lake Michigan and Its Effect on Lake Levels, Water Power and Navigation

THE ENGINEERING Board of Review has studied the past procedure and the proposed future program of the Sanitary District of Chicago, and their effects upon all interests involved, and presents the following report:

Introduction—The Chicago Drainage Canal was authorized by the Illinois Legislature in 1889, and opened in 1900. It reversed the flow of the Chicago River, diverting Chicago's sewage from Lake Michigan; improved the city's only source of water supply; ended severe water-borne epidemics; provided one of the chief links in a waterway from the Great Lakes to the Gulf, a project long promoted by the national and state government; led to a remarkable development of bathing beaches, and incidentally supplied power for public needs.

Dilution was the best method then in use for large-scale sewage disposal, and the canal was a vital factor in Chicago's phenomenal growth.

The city's growth already has exceeded the limits considered when the canal was built, and the Chicago Sanitary District, after scientific research, has planned and has under construction extensive plants for the treatment of sewage by recently developed methods, at a rate to provide additions for approximately 300,000 persons each year. This program should be continued. Its cost can be reduced by the elimination of water waste, but in any event will involve an increase in tax rates. However, a large diversion of lake water will still be required to produce satisfactory conditions.

On Sept. 23, 1924, the Board of Trustees of the Sanitary District of Chicago asked the 28 eminent engineers whose names are signed to the report to study the history and the program of that District and to report on the jurisdiction of both, and their relation to the problems of the Great Lakes. This is the full text of the findings of the board, as adopted Dec. 20, 1924. This is a summary of the essential conclusions the board has reached, but it will be followed by a technical engineering report in detail, with supporting data.

The board is officially known as "The Engineering Board of Review of the Sanitary District of Chicago on the Lake Lowering Controversy and Program of Remedial Measures."—*Editor.*

The Chicago diversion has lowered the Great Lakes about 5 inches, while diversions elsewhere, improvements of outlet channels, and climatic conditions, have caused a lowering of 2 to 3 feet. Reduced lake levels have damaged navigation and harbor works.

Lake fluctuations can be largely eliminated, and the lakes held near the highest desirable levels, by works constructed near their outlets. Such works are necessary regardless of the Chicago diversion, and their cost will be but slightly affected by it. They will protect all interests involved, increase low water flow, greatly improve navigation and harbor conditions, allow more efficient use of water for power, and make possible the restoration and protection of the scenic beauty of Niagara Falls.

Diversion of water at Chicago is necessary for sewage disposal; it prevents gross pollution of the lake; it improves navigation in the waterways from the Great Lakes down the Illinois and Mississippi Valleys; and it makes available hydro-electric energy in a region where needed. With lake and river regulation it will confer these benefits without damage to navigation in the Great Lakes and connecting waters; without affecting navigation conditions in the St. Lawrence River; and for years without reduction of power at Niagara and along the St. Lawrence River.

Recommendations—The board recommends: That the District take every reasonable measure to minimize controversy and to clear up the widespread misunderstanding of the facts regarding the Chicago Drainage Canal. The Board counsels fairmindness and avoidance of exaggeration, that the whole truth be made widely known, and that the facts be dealt with in an unbiased way by all parties.

That the District proceed as rapidly as is consistent with sound finance to carry out the following progressive program which substantially conforms with the District's plan:

(1) Des Plaines River treatment works.
(2) Calumet sewage treatment works.
(3) North Side sewage treatment works.
(4) Industrial wastes treatment works: (a) Corn Products, (b) Stock Yards and Packing Town.
(5) West Side sewage treatment works.
(6) Southwest Side treatment works.
(7) Miscellaneous treatment plants and sewers.
(8) Additional work required in connection with existing structures.

It is estimated that this program will involve an expenditure of about $125,000,000.

These works provide for complete treatment at the Des Plaines, Calumet, North Side and at both industrial waste plants, and for partial treatment at the West Side and Southwest Side plants. This program should be completed by 1945, or earlier if practicable, and includes necessary extensions of these plants to that date.

That, following the consummation of this program, supplementary works for the complete treatment of the dry weather sewage and a small fraction of the storm flow be built as may be required to maintain satisfactory conditions in the canal and rivers, and the District now adopt the policy of providing these works. Storm overflows cannot be treated.

That the District expedite the building of plants for the treatment of industrial wastes, and that the District seek early adjustment of the equitable division of cost of the same between the Sanitary District and the industries producing such wastes.

That the District formally requests the city of Chicago to put into effect without delay a practicable program of water waste prevention, including a water waste survey, and the progressive installation of meters.

That funds received from the sale of bonds be expended on new construction only; that all expenditures for administration, operation and maintenance, as well as for bond interest and bond redemption, be paid from an annual tax levy for these purposes, and that the minimum annual tax rate for the corporate purposes of the Sanitary District be increased.

That the District continue to co-operate with all authorities interested in forwarding the Lakes-to-the-Gulf waterway, and that the District make application for a permit to dredge a suitable connection between Lake Michigan and the Calumet-Sag Channel to be used for navigation and in the interest of the public health.

That a fair settlement of all damages caused in the Illinois River valley by the diversion at Chicago, for which the Sanitary District is responsible, should be made promptly.

That the District now offers to contribute its proper share of the cost of lake regulating works, to be installed in such manner as approved by the War Department.

That the District apply to the federal authorities for permission to divert from Lake Michigan an annual average of 10,000 sec.-ft. of water as measured at Lockport, for sanitary and navigation purposes, until such time as a re-appraisal shall indicate that the most beneficial use of the waters of the Great Lakes requires a reconsideration of the amount of such diversion.

The board makes the foregoing recommendations as a result of the following findings and conclusions:

Main Drainage Canal—Lake Michigan is the only practicable source of water supply for Chicago and the adjacent territory.

The Main Drainage Canal of the Sanitary District of Chicago was conceived to meet the sanitary needs of Chicago, whose domestic water supply was grossly polluted by sewage from Chicago River and from sewer outlets discharging into Lake Michigan.

The project was provided for by an act of the Illinois Legislature in 1889, which created the Sanitary District. This District is an overlying political subdivision of the state, having an area of 437.39 square miles and embracing 50 cities and villages. It has no control over the ordinary municipal activities of the city of Chicago, such as water supply, construction of ordinary sewers, etc. The Main Drainage Canal, connecting the Chicago River with the Des Plaines-Illinois River, was begun in 1892 and opened in 1900. It replaces the upper part of the old Illinois-Michigan canal, which was completed in 1848 by the state, with the aid of the federal government.

The Main Drainage Canal draws water from Lake Michigan by reversing the flow of the Chicago River and discharges it into the Des Plaines-Illinois River for the purpose of diluting Chicago's sewage and diverting it from the lake. In addition to this use, the water will also play an important part in the operation of the 9-foot waterway now under construction from the Great Lakes to the Gulf of Mexico.

The maximum capacity of the Main Drainage Canal was determined largely by the necessity that it should carry at least 10,000 sec.-ft., to prevent the flood flow resulting from occasional heavy rainfalls over the Chicago River drainage area from flushing sewage and accumulated sewage deposits into the lake.

The Illinois legislature made mandatory that the sewage entering Chicago River should be diluted with at least 3½ cubic feet of water per second per 1,000 population. The channel was therefore intended to serve a population of not more than 3,000,000.

The War Department expressly claims that it has allowed a diversion of 4,167 sec.-ft. only. The expressed reason for restricting the flow to this quantity was to avoid currents causing interference with navigation in Chicago River as it then existed.

For this reason the Chicago River has since been widended and deepened by the Sanitary District in accordance with plans approved by the War Department, and a flow gradually increasing in recent years to an average of about 9,000 cubic feet per second, including sewage, has been diverted from Lake Michigan in an effort to furnish the dilution prescribed by the Illinois state law. Express permission for any diversion through the Chicago River of more than 4,167 sec.-ft. has been refused by the Secretary of War.

Flows in the Main Drainage Canal, hereinafter mentioned, are referred to as flows at Lockport, and include sewage and the natural runoff from the Chicago River drainage area and a part of that from the Calumet. In 1924, of a total average flow during the first ten months of 9,660 sec.-ft. the sewage amounted to 1,200 sec.-ft., leaving 8,460 sec.-ft. made up mainly of lake water.

To decrease the pollution of the lake from the Calumet District, an additional canal was constructed from Little Calumet River to the Main Drainage Canal at Sag. Application was made to the Secretary of War for a permit to divert 4,000 sec.-ft. of lake water through this Calumet-Sag Channel. The permit was denied.

Sewage Disposal—The plan for sanitary improvements authorized in 1889 and executed at a capital cost to date of approximately $100,000,000 was not only sound but the best that could have been devised. It has been a success. The typhoid fever death rate has been reduced from a maximum of 174 per 100,000 inhabitants in 1891 to less than 2 per 100,000 in 1917; since then it has remained consistently below 2, and averaged 1.2 per 100,000.

Shortly after the Main Drainage Canal was opened it was realized from the phenomenal rate of growth of the population and industries of Chicago that the diluting capacity of the canal would soon be overtaxed. As early as 1908 extensive investigations were begun by the District with the view of supplementing such dilution by sewage treatment.

The war delayed matters, but as a result of these investigations, a plan involving an expenditure of about $125,000,000 was developed in 1919. In consequence, in 1921, an act of the Illinois legislature was passed providing for the extensive treatment of the sewage.

This act makes obligatory, beginning with 1925, the construction each year of additional treatment works sufficient to care for a population of not less than 300,000, until provision shall have been made for at least sixty per cent of the 1921 population, or for a total of approximately 1,800,000.

The population within the Sanitary District is now 3,300,000, the sewage from which, together with that from the stockyards, packing houses, and other large industrial plants, is equivalent to that from a population of 4,800,000. At the minimum rate of dilution prescribed by the Illinois state law the flow required through the Main Drainage Canal at Lockport would be 11,000 sec.-ft. for the actual population and 16,000 for the equivalent population. From the state of Indiana, the sewage and industrial wastes of a rapidly increasing population, numbering at present about 170,000 people, reach the Drainage Canal from the Calumet River drainage area.

Sewage disposal by dilution continues to be good practice within the limitations of available volume of water. In recent years practical artificial methods of sewage treatment have been developed, which are capable of purifying, to a high degree, large volumes of sewage. At present a number of treatment plants have already been built or are under construction by the Sanitary District of Chicago, which, when completed in the next two or three years, will treat the sewage of more than 1,000,000 people. No other city in the United States is treating the sewage of so large a population.

The District's present program, subject to modifications set forth in the detailed report, should be completed as rapidly as financial conditions permit, and thereafter an additional program should be begun, involving a further expenditure of at least $35,000,000 to provide complete treatment of the dry weather sewage.

This sewage treatment program, in conjunction with works now built or under construction, supplements dilution, is sound, and should produce satisfactory conditions in the Des Plaines-Illinois River. Sewage treatment would be facilitated by a reduction of Chicago's present excessive water consumption.

To abandon the Main Drainage Canal and again discharge the sewage into Lake Michigan, even though the most effective means be provided for purification of the sewage and the water supply, would be a serious backward step in sanitation. Failure to take reasonable and proper advantage of natural and artificial conditions would not be justified.

Should the volume of lake water be limited to 4,167 sec.-ft., extensive deposits of sewage solids would be formed in the Main Drainage Canal, there would be frequent reversals of flow of the Chicago River and consequent pollution of the lake water and lake front, and intolerably offensive conditions would be created in the Chicago River and its branches, and along the Des Plaines-Illinois River.

Controlling works in the Chicago River to prevent reversals of flow in the case of unusual storms would obstruct navigation, reduce the capacity of storm sewers, and cause flooding in the heart of Chicago. With a diversion of 10,000 sec.-ft., and efficient operation of the Drainage Canal, the periods of flow of the Chicago River into Lake Michigan cause by storm floods will be of infrequent occurrence and of short duration.

To maintain the Des Plaines-Illinois River in a satisfactory condition will require a substantial flow of lake water, even after all the sewage shall have been treated by the most effective practicable means now available.

While a diversion of 10,000 sec.-ft., and at times more, is necessary for sanitary purposes during the warmer portion of the year, the amount may be diminished at other times without seriously reducing the dilution efficiency of the canal. Authorization of the full amount is necessary, however, to reduce the danger of the reversal of Chicago River during heavy rainfalls, and to provide for contingencies.

An increase in the present tax rate for the purposes of the Sanitary District will be necessary for carrying out the program recommended.

Unsatisfactory conditions in the Illinois valley can be remedied by correction of the present insanitary condition of the canal and rivers and by the regulation of levee construction to prevent undue restriction of the flood channel. Excessive flood heights in recent years have been caused chiefly by this restriction.

The Illinois State Division of Waterways has reported that the maximum discharge of the Illinois River during the flood of 1922 was 109,000 sec.-ft. at Beardstown, that

the flood height there was raised 5 ft. 5 in. above what it would have been if uninfluenced by levees constructed since 1904, and that but 6 in. of the total flood height was to be attributed to the discharge of the Main Drainage Canal.

Water Supply: Lake Front—Chicago's water consumption is about 800 m.g.d., equivalent to 275 gal. per capita, about one-half of which is wasted. General installation of meters will assist in preventing a large part of this water waste, thereby relieving the Water Department of a serious burden, and materially reducing the construction and operating cost of sewage treatment plants.

The Sanitary District has no control over the water supply of the city of Chicago. The water as delivered to the consumer is safe from the hygienic standpoint, but it frequently contains objectionable turbidities and also unpalatable tastes due to chlorination. To make the water supply satisfactory, the city of Chicago will be required to extend tunnels to deeper water, or to build filters, or to do both, and to improve the tunnel system as may be required in the interest of public health. Diversion of the lake water necessary for the other objectives dealt with in this report will reasonably protect the Chicago water supply.

The extensive and growing use of the lake front of Chicago by bathers has directly resulted from the diversion of sewage from the lake, and is of great benefit to the public.

Lake Levels and Their Regulation—In 1913 the United States sought to enjoin the Sanitary District from diverting from Lake Michigan more than 4,167 sec.-ft., and in 1923 the United States District Court granted this injunction. An appeal was taken to the United States Supreme Court, where the proceeding is now pending.

The taking of testimony in this suit was concluded in 1914 and as a basis for injunction it was set forth, by navigation and other interests in opposition, that there was a lowering of lake levels of from 4 to 6 in., with a consequent damage to navigation in the Great Lakes system.

Accepting the conclusion that the diversion of lake water at Chicago has contributed to the present low stages of the lakes, the Sanitary District made an offer to the United States to pay the cost of remedial works to compensate for the lowering caused by its diversion, these works to be designed by the United States Army Engineers, and to be built under their direction.

The Great Lakes rise and fall 3 to 5½ ft. during long periods. The present low stages are due partly to natural variations in rainfall, evaporation, and ice conditions; and partly to diversions through the Chicago Drainage Canal, the Welland Canal, the Black Rock Canal, and the improved Erie Canal, and for water power at Niagara; to storage of water in Lake Superior; and to the enlargement of the channels of the St. Clair and Detroit Rivers for navigation purposes.

With a diversion of 10,000 sec.-ft. at Chicago, and without regulation of the outflow from Lakes Huron and Erie, the United States Army Engineers report that such a diversion would ultimately lower Lakes Michigan and Huron 5½ in. This board accepts this figure.

The outflow from the Great Lakes can be controlled at moderate cost by works of simple character. By these works, the lakes can be held at as high stages as prevailed in the period from 1883 to 1887, regardless of the amount of water diverted from the lakes and connecting rivers.

There is a distinction between "compensation works," such as submerged weirs, by which lake levels may be raised, and "regulating works" by which both the level and the discharge can be so controlled that the surplus of water in cycles of large yield can be conserved in storage for increase of outflow in years or seasons of scant supply.

Regulating works are neither experimental nor are their effects problematical. This is well illustrated by the works at the outlet of Lake Superior, which have successfully raised and controlled the level of that lake for the past eight years.

A reduction of the diversion at Chicago to 4,167 sec.-ft. would raise the lake levels only 3 in.; whereas proper regulating works would raise these levels ten or more times as much, even with an annual average diversion of 10,000 sec.-ft. at Chicago.

No locks would be required for *compensating* works ample to restore all lowering of lake levels due to the Chicago diversion; but *regulating* works at the outlet of Lake Huron, by which both elevations and discharge can be controlled, would ultimately give better service for both navigation and power. Such regulating works would require a lock of not exceeding 5-ft. lift, the passage through which would delay a boat by about one per cent of the total time required from Lake Superior to Lake Erie ports. This delay would be compensated by at least 10 per cent increase in cargo capacity, due to the greater depth of loading.

Regulating works for Lake Erie can be located near Niagara Falls, and can be combined with an international bridge now greatly needed. Various designs and locations for regulating works in the Niagara River have been recommended respectively by the Deep Waterways Board in 1900; the International Waterways Commission in 1913; the United States Army Board of Engineers for Rivers and Harbors in 1920, and others. This board presents a new plan for regulating works located 1½ miles upstream from the Falls, consisting chiefly of a drop-gate weir combined with a new international highway bridge, by which the river surface can be regulated to any height above the present low water that may be found best between 1 ft. and 10 ft. Lake Erie can thus be maintained ordinarily at an elevation 1.4 ft. higher than its present mean, and the depth correspondingly increased in the Niagara River all of the way upstream from the city of Niagara Falls to Buffalo, past the Barge Canal entrance at Tonawanda. These proposed works would make the upper Niagara River an extension of Buffalo harbor, would facilitate a large industrial expansion along the river banks, and would assist in improving ice conditions.

Many statements have been made of the money losses to navigation interests by reduced channel depths. Such reduction of depths can be eliminated by regulating works, and applying the same unit values as are used in such statements, the total money gains resulting from the large increase in depths which regulating works would create would give to the navigation interests such large benefits that there is no doubt as to the desirability of such works.

Water Power—The water diverted from Lake Michigan, formerly wasted through the control works at the outlet of the Main Drainage Canal at Lockport, is now utilized to develop hydro-electric power, and the surplus power not required for the works of the Sanitary District is sold to the city of Chicago and other cities in the District for municipal lighting and pumping, and to industries. When the sewage treatment works, now building and planned, are completed, this entire power development will be insufficient to meet the operating requirements of the Sanitary District.

Full utilization of the water in the Main Drainage Canal and the Des Plaines-Illinois River for the development of power is desirable. With the completion of the Illinois Waterway, power can be produced at its navigation dams for low installation costs.

By reason of the demand for power and its higher market value, a cubic foot of lake water is now worth as much for power production in Illinois as at Niagara, even were the full available head between Lakes Erie and Ontario utilized. There is no economic loss to the country at large by using lake water for power in Illinois instead of at Niagara.

Furthermore, under present treaty restrictions, the water diverted at Chicago does not now and will not prevent the development of all the water power which it is possible to develop at Niagara by diversions now allowed by treaty.

On the Upper Illinois River the natural low water flow is approximately 500 sec.-ft. Any additional water diverted by the Drainage Canal from Lake Michigan would meet a future demand for condensing water in steam power plants located near the coal mines of the Illinois valley, and would thereby facilitate the production of power by such plants.

Any water diverted from Lake Michigan reduces the flow of the Niagara and St. Lawrence Rivers and the power that might ultimately be developed on these rivers; at present not quite two-thirds of the power available under treaty restriction is utilized at Niagara.

Work of simple character proposed by the U. S. Army Engineers can be built which would more evenly distribute the water passing over Niagara Falls. With this proposal the board concurs. Such work would save the Falls from the self-destruction now in progress, would restore and preserve their scenic beauty, and at the same time would render possible the use of more water for power production.

The regulating works for increasing and regulating lake

levels can be used also for equalizing lake discharges, thereby increasing their present minimum outflows. This would largely increase the prime or continuous power which could ultimately be developed in the Niagara and St. Lawrence Rivers, but such further power development at Niagara would necessitate modification of the present treaty.

There are no treaty restrictions as to the use of the St. Lawrence water for power, but less than 10 per cent of the available power is utilized. There will be no economic loss of power on either the Niagara or St. Lawrence River by reason of the diversion of water from Lake Michigan until 95 per cent of the available power at each location is developed.

St. Lawrence Waterway to the Sea—The diversion of 10,000 sec.-ft. of water at Chicago, with regulating works proposed, would in no way interfere with the establishment of a deep waterway from the Great Lakes to the ocean by any one of the several routes that have been proposed. For the deep water route down the St. Lawrence, regulating works will be required, which can be operated in the same manner as those proposed for the Great Lakes, and would eliminate the effect of any diversion at Chicago.

Lakes-to-Gulf Waterway—For more than 100 years both the United States and the state of Illinois have proceeded on a policy of improving the navigation facilities of the country by connecting the Great Lakes through Chicago with the Gulf of Mexico. Construction work is now in progress on a modernization of this waterway.

The state of Illinois is spending $20,000,000 in building the most expensive section of a 9-ft. barge waterway. The United States already maintains 6 to 8-ft. navigation over the remaining distance to the Gulf, and has outlined a 9-ft. project.

An average annual diversion of 10,000 sec.-ft. at Chicago would reduce the cost of completing and operating the 9-ft. waterway from the lakes to the Gulf of Mexico, would improve navigation conditions down to and below Memphis, and would dispense with four of the nine locks which would be required with a diversion of 1,000 or 2,000 sec.-ft. This would make feasible a 9-ft. channel without locks from the Gulf of Mexico to within 100 miles of Chicago.

A diversion of 4,167 sec.-ft., while probably enabling the four locks and dams now in the Illinois River below Utica to be dispensed with, would require extensive dredging even to produce narrow channels; whereas a diversion of 10,000 sec.-ft. would reduce the cost by about $5,000,000, and would not only dispense with these four locks but give wider and deeper channels and permit free and faster navigation with larger tows.

The improved Illinois waterway will adequately connect the Mississippi valley with the Great Lakes. Such a connection will encourage navigation, and will give the Middle West and Gulf states a better opportunity to share in the benefits to be derived from ample and desirable facilities for water-borne commerce between the Gulf and the Lakes. Such a waterway is of international importance, and with the completion of the improvements in the Illinois River is a possibility within three or four years.

A widening of the Calumet-Sag Channel and its adequate extension to Calumet Lake and Calumet River are necessary to provide a satisfactory 9-ft. waterway connection for barge navigation between the Lakes-to-Gulf Waterway and the rapidly growing Calumet District.

Treaty Limitations—Of the drainage area of the Great Lake above St. Regis where the international boundary line leaves the St. Lawrence River, about 50 per cent more is in the United States than in Canada. Lake Michigan contributes 50,000 sec.-ft. to the run off from the Great Lakes.

By the treaty of 1910 with Great Britain, diversion of water at Niagara for power may be granted by the United States not in excess of 20,000 sec.-ft., and by Canada not in excess of 36,000 sec.-ft.

Under the treaty, Lake Michigan is to be classed as a tributary to boundary waters. Article 2 of the treaty permits diversion from such tributaries, but when injury results from diversion on either side of the boundary, the injured party is given the same legal remedies ". . . as if such injury took place in the country where such diversion or interference occurs; but this provision shall not apply to cases already existing . . ."

Article 8 of the treaty prescribes the following order of precedence among the various uses of boundary waters:

"(1) Uses for domestic and sanitary purposes; (2) Uses for navigation, including the service of canals for the purposes of navigation; (3) Uses for power and for irrigation purposes."

In Conclusion—A practicable solution of the problem at Chicago is feasible. Such solution will benefit every interest, and can be reached by a sane consideration of all aspects and by elimination of prejudice.

Suitable regulation of lake levels is the chief feature of any satisfactory solution, and will permit the diversion necessary for the sanitation of Chicago and for the waterway from the Great Lakes to the Gulf.

The foregoing report, presenting its essential conclusions in summary form, was unanimously adopted by the Engineering Board of Review of the Sanitary District of Chicago on the Lake Lowering Controversy and Program of Remedial Measures.

W. W. DeBERARD	WYNKOOP KIERSTED
GEORGE G. EARL	MORRIS KNOWLES
HARRISON P. EDDY	J. L. LUDLOW
GEORGE P. FENKELL	RICHARD R. LYMAN
JOHN R. FREEMAN	ANSON MARSTON
JAMES H. FUERTES	ARTHUR E. MORGAN
JOHN H. GREGORY	F. H. NEWELL
C. E. GRUNSKY	ASA E. PHILLIPS
J. F. HASSKARL	C. S. RICHÉ
T. CHALKLEY HATTON	FRANCIS LEE STUART
JOHN B. HAWLEY	EZRA B. WHITMAN
ROBERT E. HORTON	SHERMAN M. WOODWARD
CLARENCE W. HUBBELL	

GEORGE W. FULLER, *Chairman*
E. E. HASKELL, *Honorary Chairman*
PAUL H. NORCROSS, *Secretary*

State Land Settlement Proposed for South Carolina

ENACTMENT of a state land settlement act and of a land mortgage association act in South Carolina has been proposed to the legislature of the state by a commission which during the last year investigated the subject at the direction of the legislature. The commission studied in particular the land settlement work in California, Wisconsin and North Carolina. In its report it recites the fact that only 5,000,000 acres or less than one-third of the land in South Carolina is in cultivation and that the acreage in production is growing less each year. Tenancy is increasing, farmers are leaving their farms and negro labor is migrating. Some 28,000 white families are living on farms as tenants. Large landed estates of former times have not yet been split up and converted into individual owner-operated farms, and it is believed that "thousands of acres of these lands will become a wilderness" unless the state by organized effort develops them.

The commission therefore framed in outline an act modeled after the California Land Settlement Act, to provide for the creation of a South Carolina Land Ownership Board, whose function it will be to supervise the sale and colonization of farm land on a basis fair to both seller and settler, and to administer an appropriation of state money to be loaned to farmer buyers against mortgage. The second proposed act would authorize the formation of land mortgage associations, to loan money on notes and mortgages as an aid to land settlement. The commission also proposed the creation of a revolving fund of one million dollars of state money to be loaned to settlers on a basis of long-time (up to 36 years) refunding. It laid down the principle that "state aid, if considered at all, must be considered as a straight-out business proposition and solvent enterprise, not a charity." R. I. Manning is chairman of the commission, and W. H. Mills, of Clemson College, is secretary.

Constructing Concrete Roads by Vibration

Vibration Produces Dense Concrete So Hard That It Can Be Walked Over When Green and Is Not Injured by Heavy Rainfall

General Process and Special Plant

(EDITORIAL SUMMARY)

Construction of concrete roads by a special vibrating machine to compact the concrete has gained noticeable consideration in the Middle West.

In 1924 the method was employed on roads in 16 states of which a dozen are the heavy road-building states of the Mississippi valley.

So far the method has been employed rather more on streets and park drives than on rural highways but it has a specific mention in some state highway department specifications and is generally recognized by state highway officials as acceptable. It is known as vibrolithic construction.

It is to be kept in mind that vibrolithic is a method of construction and not a type of road. Any concrete road slab or pavement base design, whether plain or reinforced, with thickened edges and longitudinal joints or without them, can be constructed by the process.

This presentation of the process consists of three separate articles: (1) General Process and Special Plant based on an editorial study, (2) Practical Construction Experiences by a well-known contractor and (3) Special Construction Features by a representative of the company controlling the process.—EDITOR.

WHILE vibration is a construction process, a quite different structure or character of concrete is an element of the process. This difference is in the relation of the amount of cement to total aggregate, and particularly in the relative amounts of fine and coarse aggregate. The application of vibration and pressure causes the individual particles of coarse aggregate to nest closer to each other, thereby reducing the amount of mortar between the large particles. This does not mean leaner mixture. There is less cement per cubic yard because there is less mortar per cubic yard. The amount of cement in proportion to the fine aggregate is practically the same as in ordinary concrete.

As a construction method the vibrolithic process is distinguished mainly by three things: (1) It is a machine-performed process; (2) it employs the principle of consolidating concrete by vibration; (3) it gives immediately, by hammering broken stone into the green slab top, a firm load-bearing surface. Categorically the claimed advantages are: (1) Economy of machine consolidation, (2) exceptionally dense and strong concrete, and (3) less care in protecting the finished surface and quicker use of the road. The evidence offered will appear as the discussion proceeds.

Special Plant—It has been indicated that except in the matters of wedging broken stone into the concrete surface and of consolidating the concrete by vibration the vibrolithic process involves no changes in construction processes. The materials, the forms and templets, the mixing and spreading, the finishing and the curing conform to practice made familiar by thousands of miles of concrete road construction. Only the special plant procedures of the method, therefore, are given attention. These are indicated by Fig. 1, which shows operations on the East Chicago-Hammond road.

The special equipment comprises a pressure vibrator and the mats on which it travels. On some operations a carriage riding on the forms ahead of the vibrator carries the surfacing stone, but more often the stone is spread by hand shovels from stock piles along the road. The vibrator is the distinctive device. It consists of a truck-mounted gas engine.

The impulses transmitted by the engine are of two kinds. First, there is the impact due to the explosion of the gas in the cylinders; second, another light rapidly-repeated blow is transmitted through the platforms to the plastic concrete by unbalancing the motor, causing a slight whipping action in the crank shaft. The unbalancing is done by drilling holes in the rim of the flywheels, in which are inserted removable lugs. The weight of these lugs is about one ounce each. The combined weight of the piston and connecting rod which must be balanced is about 16 ounces, part of which is compensated by the usual method of counterbalancing. When the machines come from the factory they are balanced by inserting these lugs in the proper position to balance the motor. Removal of one of any of these lugs throws the motor out of balance by the weight of the lug, approximately one ounce. Shifting the lug to the opposite side of the flywheel, 180 deg. around, throws the engine out of balance by twice the weight of the lug. Having four or more lugs in each flywheel this means that when four lugs are shifted to the opposite side of the flywheel, the motor will be thrown out of balance approximately eight ounces, or practically one-half the weight of the piston and connecting rod.

The truck wheels are 6 in. in diameter, with wide tires, and like the frame are of steel. The machine is propelled by hand back and forth over the mats. These are 12 ft. long and 16 in. wide. Each consists of three longitudinal boards about 2¾ in. wide separated by spaces. On these boards are nailed transverse cleats ⅛x1⅛ in., spaced ⅝ in. apart. The mat is laid on the concrete with the cleats down. The view Fig. 1 indicates very clearly the equipment and its use.

One very essential thing in connection with the platforms is that the width in relation to the width of the vibrator truck is so adjusted that it is not possible to have the vibrator resting on a single platform. This assures bridging over the gaps between platforms, and prevents sinking one platform deeper than the adjoining platforms on each side are sunk. The standard width of platform is 16 in. and the width of the vibrator truck is 24 in. Fractional-width platforms are furnished with each outfit so as to fill out any space less than the standard width of 16 in. Usually these fractional width platforms are slightly more than one-half

or three-fourths of the standard width. The remaining one-quarter, or 4 in., can always be taken up by spreading the platforms slightly. In this way any width of pavement can be completely covered with platforms, still retaining the advantage of standard equipment, and keeping special equipment at a minimum.

Surfacing Method—As developed by the vibrolithic engineers especial care is exercised in the surfacing methods. The construction advocated is:

Immediately upon the depositing and correcting the surface of the concrete, there shall be cast upon it a coating of stone, graded approximately through a 2½-in. screen and retained on a 1 in. screen. The stone shall be clean, sound, crushed material which shall not contain soft particles and shall have a French coefficient of wear of not less than ten. The stone shall be cast upon the pavement by a method which will equally distribute a single course of the size specified over the surface area of the concrete slab. A cubic yard of surface stone shall cover not more than the following areas: 6-in. slab, not more than 55 sq.yd., 7-in. slab not more than 50 sq.yd. and 8-in. slab not more than 45 sq.yd.

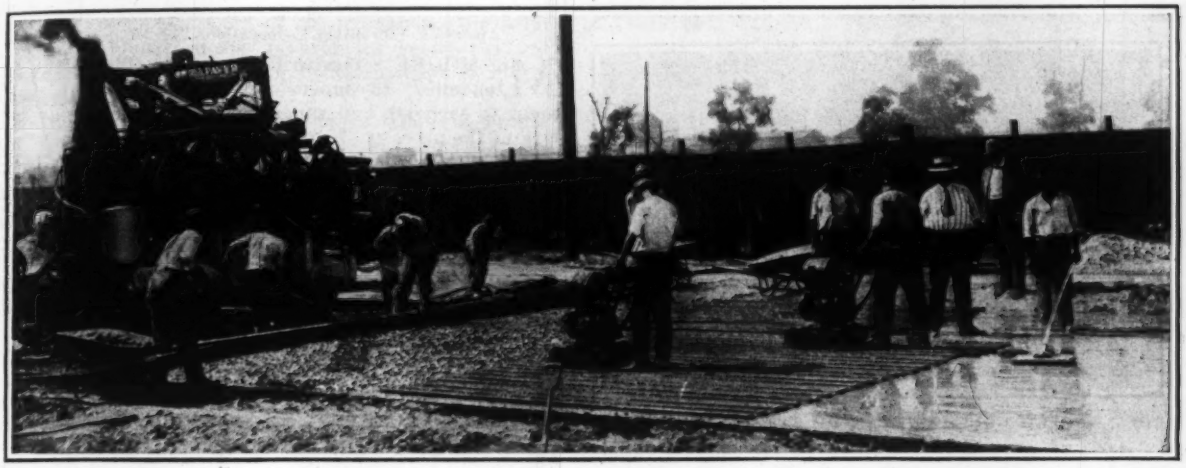


FIG. 1—VIBROLITHIC ROAD BUILDING OUTFIT

* * *

Practical Construction Experience

By S. D. Moore
Moore-Young Construction Co., Waterloo, Iowa

FROM a contractor's standpoint the operation of building vibrolithic concrete roads is identical with that of standard concrete construction and is, therefore, in most respects entirely familiar. The procedure is merely to lay a regular concrete pavement of the mix and thickness specified, using any of the usual and standard methods up to and including the strike-off. The last must be performed with unusual care so as to get perfect the contour and surface. The vibrating or compression process is so uniform that any unevenness in the surface as struck off remains there. There is no chance to iron out the kinks afterward; the concrete after vibrating is so dense that nothing short of a pick or crowbar will disturb it. We had trouble with this feature on the first of the four jobs undertaken, but it disappeared as soon as the crew once got it through their heads that care is necessary. On highway work where a standard finishing machine is used to strike off, this difficulty does not arise.

The only other item encountered that might be a source of trouble is the bracing of side forms. Any carelessness in this respect results in the bulging of the forms due to vibrations and pressure applied causing a depression in the surface, which, as stated before, cannot be successfully patched up.

After the concrete is laid and brought to a true surface, the top stone, consisting usually of crushed granite, is cast upon it by hand from small piles or boxes conveniently placed alongside. The cost of transporting and spreading the top stone is in almost all cases about the same as is saved by the contractor over the cost of the final finishing of ordinary concrete, so that the total labor cost on vibrolithic is the same as that for a standard job of the same thickness and amount of reinforcing. The firm makes no distinction in its estimating for bidding, but is beginning to lean a little in favor of the vibrating process because of the rather consistent increase in daily output shown by past experience when the opportunity arose for parallel jobs where comparisons were possible.

After the top stone is cast and spread, the slatted platforms are placed on the surface and the vibrators are run over them. This takes but a few moments and follows right up to the mixer so there is little or no overtime or night finishing. Nor is there any danger from being caught by rain. The firm's first experience with a storm on a vibrolithic job was rather amusing. Upon the sudden approach of an unexpected shower the S.O.S. call was sent for the emergency truck and the canvas. Through one of those occasional ball-ups that seem to happen even in the best regulated construction families, the canvas did not arrive until too late. The vibrolithic superintendent did not seem to be at all perturbed, his composure being accounted for when to our amazement the shower not only did no damage but left the best finished block on the entire job. While one would hardly recommend trying to pour concrete pavement in a down-pouring rain, a properly timed shower on vibrolithic is benefical rather than otherwise.

The original specifications provided that the mortar should all be washed from the surface down to the granite, but the demand of the public for a smooth looking job upon completion induced the engineers to leave the excess mortar on the surface, belting or floating it to a finish. This gradually wears off and there is no objection to leaving it unless the aggregate contains a large percentage of dirt and impurities, which naturally come to the top and sometimes cause a slight

scaling of the mortar down to the topstone. Another rather startling thing is to see the finishers walking about on the green concrete which is so compact that no impression whatever is made, Fig. 2.

The curing is accomplished by any of the regular methods, puddling, sprinkled earth, or seal coats. The most satisfactory results have been had with silicate of soda. The early development of slab strength permits the streets to be opened to ordinary traffic in about ten days instead of the usual three or four weeks.

In certain localities where the commercial sands carry a large percentage of pea gravel, there has been some difficulty in adjusting the mix when the engineer in charge is not familiar with the process and does not understand the necessity of getting enough fine sand to make the mortar required to fill all the voids. Until the voids are completely filled and the excess water is all out, no mortar will come to the surface. On the other hand, it is of great advantage to be working under specifications written by good authority and under intelligent superintendence in towns where the local city engineer has not had either the opportunity to observe, nor experience with, new developments and large operations such as are involved in street or road paving.

FIG. 2—FRESH CONCRETE CAN BE SAFELY WALKED ON

In 1922, at Missouri Valley, Iowa, with a caterpillar crane, central proportioning plant, auto-car trucks, good weather conditions, 21-E mixer, and a fifty-fifty sand and gravel mix the firm laid 77,891 sq.yd. of 6-in. vibrolithic in 65 operating days, an average of 1,198 sq.yd. per day. The maximum day's run was 2,032 sq.yd. and the maximum week's run was 10,266 sq.yd. Much of this work was on very steep grades where, surprisingly, there was less difficulty than with regular concrete.

In 1923, at Le Mars, Iowa, with the same proportioning plant and crane, Ford trucks, 21-E mixer. crushed stone and sand aggregate, the firm laid 109,644 sq.yd. 6-in. vibrolithic in 72 operating days, an average of 1,523 sq.yd. per day. The maximum day's run was 1,985 sq.yd. and the maximum week's 11,203 sq.yd.

At the same time in an adjoining town, Storm Lake, Iowa, with a twin outfit and organization, the record was 73,068 sq.yd. of 6-in. reinforced concrete, using the same aggregate, in 72 operating days, an average of 1,014 sq.yd. per day. The maximum day was 1,482 sq.yd. and the maximum week was 7,535 sq.yd. Being mesh reinforcement, some of the difference in output is accounted for by work of installing the steel, but much of the gain is caused by the ability to pour up to the last minute and not stop for an ordinary rain.

While very reluctant to bid upon this method of construction and entering into our first contract with some misgivings, after three years' experience during which time the firm has laid an equal or greater amount of standard concrete, it is, as a whole, more than pleased with the (vibrolithic) results. Balanced against the difficulties arising from careless workmanship and the inconvenience of distributing the top stone, are the advantages of increased output, freedom from storm worries, absolute absence of maintenance expense, double inspection, and the satisfaction that comes to any builder in the knowledge that he has produced for his community an enduring monument, representing the sum total of scientific study and practical experience in concrete construction to date.

* * *

Special Construction Features

By H. L. Tillson
American Vibrolithic Corporation, Des Moines, Iowa

MR. MOORE refers in the term "intelligent superintendents" to supervisors who accompany equipment to each job and supervise its use and the application of the process. Naturally we aim to have for supervisors only very high-class men. All of them are more capable than the average inspector a contractor encounters on work. Many have been superintendents for contractors for a number of years, and are entirely able to take over a contractor's operation and successfully handle it.

It was first thought by contractors that it would not be possible to introduce men into their organization and give them any supervisory powers whatsoever without resulting in a conflict of authority which would prove disastrous. New contractors in new territories working with us for the first time are sometimes fearful of this same thing, but we have proven that by the use of a little tact and diplomacy the men are able to secure results without affecting the contractor's interests adversely. It is this thought that Mr. Moore has in mind by his term intelligent superintendents.

A little explanation of the term fifty-fifty sand gravel mix in the Missouri Valley case would probably not be amiss. The fine aggregate delivered on this particular job contained a considerable percentage of material retained on a ¼-in. screen. The coarse aggregate contained very little material below ½ in., although a considerable percentage of the coarse material ran from ½ in. to ¾ in. in size. The bins were set so as to deliver practically equal amounts of the fine and coarse aggregate. However, an analysis of the resulting mixture using the ¼-in. screen as a separation point would show a mixture approximately as follows: 1 part cement to 2 parts aggregate finer than ¼ in., to 4½ parts coarser than ¼ in. This mixture conforms very closely to the mixtures usually used in our work.

We have had considerable trouble attempting to use so-called fifty-fifty mixtures, which have a high percentage of very fine sand and a low percentage of coarse gravel, which would give vastly different results than was the case at Missouri Valley, due to the difference in grading of material. We would like to ask that caution be exercised in using this term fifty-fifty mixture, for the reason outlined. The mere fact that bins are set to deliver equal amounts of material commercially produced and termed fine and coarse aggregate, does not necessarily mean that the resulting proportion will be different than according to our standard specifi-

cations when the upper and lower limitations for fine and coarse aggregate are clearly defined.

Another point in this connection which Mr. Moore mentions in a previous paragraph is the difficulty in adjusting the mixtures when the aggregate contains a large percentage of pea gravel. Since the platform cleats are spaced ⅝ in. apart, it is easy to see that pebbles ½ in. or slightly more in diameter can be forced up between the cleats. If the material from ¼ to ⅝ in. exceeds about 30 per cent of the total volume of coarse aggregate, considerable of these pebbles will be forced up between the cleats, and appear in the mortar ridges, which must be later distributed over the surface making a thin coating. Owing to the hardness of green concrete after the vibrators have packed it thoroughly, it is impossible to bury these small pebbles as can be done in ordinary concrete. Since their diameter considerably exceeds the depth of the mortar coating after the mortar ridges are spread over the entire surface, the effect is much like trying to finish marbles into a billiard table with a belt.

This condition can usually be corrected by a proper

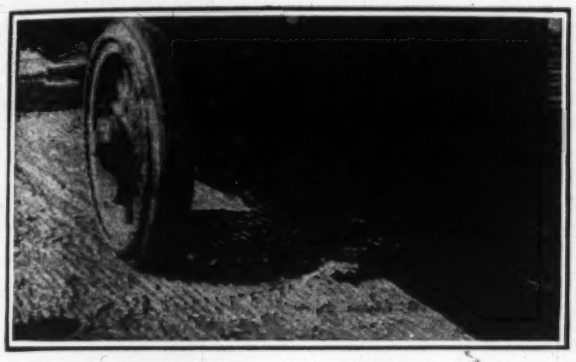


FIG. 3—TRUCK WHEEL LEAVES ONLY SHALLOW RUT IN GREEN CONCRETE

adjustment between the amount of fine and coarse aggregate in the mixture. When the fine aggregate is increased in approximately the same proportion as the coarse aggregate is decreased, or vice versa, there is practically no change in the volume of mixed concrete, and also no change in the amount of cement in proportion to the volume of mixed concrete, the only difference being in the way the concrete packs, and the facility with which the voids of both fine and coarse aggregate are completely filled.

As emphasizing further the weatherproof advantages of the stone surfacing, ordinary rainfall does not affect the surface in any way. This is due to the fact that the pavement is very thoroughly solidified or packed by the vibrators, and the surfacing stone is also wedged tightly into the surface and prevents erosive action below the very thin mortar coating on the surface. Let us note an extreme example of precipitation amounting to practically 3 in. falling in slightly more than 30 minutes. This cloudburst occurred while the contractor was working on a six per cent grade and came so suddenly there could be no preparations made for protection. The machines, platforms and other tools were left standing just as the men dropped them when the storm began. The water flowed over the green surface for a full half hour more than 6-in. deep.

It was the expectation that the entire pavement laid within the previous two or three hours would be completely washed out. After the flow subsided everyone was very much surprised to see that not even all of the thin mortar coat, approximately ⅛ in. in thickness, had been removed. In only a very few places was the mortar removed from between the surfacing stone particles. In these cases the washing action was confined to very small areas and the depth of the erosion was very slight, so slight that no attempt was made to plaster the top to fill up the depressions, and the pavement is still in service in exactly the condition it was as the storm subsided. Fig. 3 showing a truck backed on the green concrete immediately behind the platforms is a good indication of the reason why ordinary rainfall does not affect green vibrolithic pavement.

As a construction process vibrolithic is controlled by the American Vibrolithic Corp., Des Moines, Iowa, A. R. Hirst, chief engineer. It was first used in Texas some 15 years ago.

Needed Tests on Structural Steel

BY FRANK BURTON
City Building Commissioner, Detroit

Extract from a paper "Municipal Building Inspection and Steel Fabrication," read before the American Institute of Steel Construction Nov. 14, 1924.

MANY questions regarding structural steel remain to be answered, and an enormous amount of testing work must be done. The results should then be compiled into a single volume so that it will be possible for the student of structural steel to refer to these data without the necessity of spending weeks and months searching old magazines for scraps of information. A few points which occur to me and which are still undetermined are:

(1) The area of stiffeners on a plate girder.

(2) The value of structural shapes subject to torsion.

(3) Rivets in tension. These are used occasionally in spite of the prejudice against the practice. In testing some sixty rivets driven with air hammers by some five or six different shops, I found recently that the actual elastic limits were from 34 to 39,000 lb. per sq.in. and the ultimate strength from 60 to 64,000 lb. The results were very consistent and indicated that rivets might be safely used in tension with a stress of 16,000 to 18,000 lb.

(4) Electrically welded connections. These are coming into use and will eventually be a great assistance to the industry. Such tests as I have been able to make indicate that the results are very uniform and that the actual section of the weld will resist from 47,000 to 48,000 lb. per sq.in. in tension. I have been unable to learn much about its resistance to shear but it is high.

(5) Fireproofing of steel. Undoubtedly many of our present methods of fireproofing are unnecessarily expensive and some of them are very faulty. Economy in fireproofing would give a great competitive advantage to structural steel. Nevertheless very little intelligent work has been undertaken. We have many theories as to fireproofing, most of which are probably wrong. Experimental work has progressed slowly because students have confined themselves to large and expensive tests. I have found it possible to obtain many valuable data with a small furnace operated for a dollar a day.

(6) Wind Pressure. Our knowledge of wind pressure at the present time is very inadequate and there is no doubt that a great deal of money is spent annually in providing unnecessary wind bracing. The first step in solving this problem is to determine accurately the wind pressures on models of buildings. This can be done in a wind tunnel and I hope that the Massachusetts Institute of Technology will attempt some work on this within the next year.

These are only a few of many points that might repay big dividends on the money invested for making a thorough investigation. I believe that it is to the interest of the industry to demand that it provide the means for making these and other investigations.

construction" is meant the gradual development of the roadway and drainage structures as funds become available. Metal of gravel, stone, or slag is applied and traffic bound, thus furnishing a base for a future pavement.

The mileage of "stage construction" was financed by the state and counties at the rate of $4,000 per mile, the richer counties paying 50 per cent and the poorer counties 25 per cent or 40 per cent. It was impossible to finance this mileage for paving and was physically impossible to pave this amount within a year's time. After a rapid survey of the situation, it was decided to construct the unpaved portion under the "stage construction" plan, thereby getting the people out of the mud in one year. Work was started in the fall of 1923 and about 18 miles completed. At the present time 134 miles are completed and 14 miles are graded and are ready for metal.

Briefly, the organization consisted of one construction engineer in the field with general supervision, and three division engineers in whose divisions the road was located with direct charge. Under the division engineers were one superintendent and one or more foremen in each county. Surveys were only made where there was a radical change in alignment or difficult grading. Construction procedure was as follows:

The mileage was divided into approximately 15-mile sections. The superintendents were equipped with 10-ton tractors, 12-ft. graders with backslopers, scrapers, trucks, air compressors and drills, ½-cu.yd. truck cranes, bucket loaders, belt conveyors, trucks and small tools. All work was done by force account, excepting the dredging of river gravel.

The right-of-way was first cleared of weeds, brush, trees, large rocks, and debris. The roadbed was then graded to an average width of 24 ft. The greater share of this grading was side hill cut, the earth being moved with graders and tractors, and in some instances with steam or gas shovels. Some end haul was made with scrapers or teams, though mostly with trucks. The roadbed was graded to a flat section with little crown, it being desired to work the crown into the road with the metal. All small structures were repaired or rebuilt.

After the roadbed was graded the first application of gravel or crushed limestone was applied, approximating 1,000 cu.yd. per mile. This metal was applied uniformly with trucks through a spreader box, and spread with a small grader until there was only a thin application of about 1 in. on the subgrade, the surplus being pushed onto the shoulder. This thin application packed rapidly and did not appreciably hinder traffic. The surplus metal was dragged in as rapidly as it would pack under traffic. In this manner the surface was gradually built up of thin layers of metal thoroughly packed and knit together by traffic. The thickness of metal used was dependent upon roadbed conditions. In some instances where poor subsoil conditions obtained, a telford base was constructed as a greater thickness of metal was applied. A portion of the first course of gravel was not crushed. The wearing course, however, was crushed so that the aggregate would pass a 1-in. ring.

The metal for this work was local limestone and gravel. As gravel was chiefly used, it was obtained from the Ohio River in most instances, and delivered by contract into a 30-ton bin on the lower bank of the river. The contractor loaded his barges with a 1½-cu.yd. clamshell or suction dredge. The barges were towed to the unloading point and unloaded with a 1½-cu.yd. clamshell bucket with an 84-ft. boom mounted on a barge. A maximum of 1,000 cu.yd. of gravel was delivered per day with an average of 600 cu.yd.

It was necessary to elevate this material from the bin at the water's edge to the upper river bank, a distance of about 200 ft. with a vertical rise of approx-

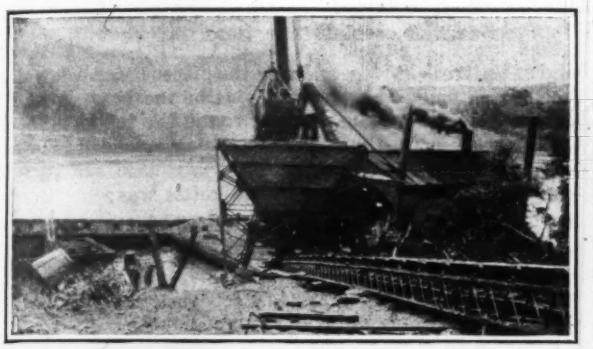


FIG. 1—HOPPER AND PART OF 200-FT. CONVEYOR

FIG. 2—PORTABLE BELT CONVEYORS AT STOCKPILE

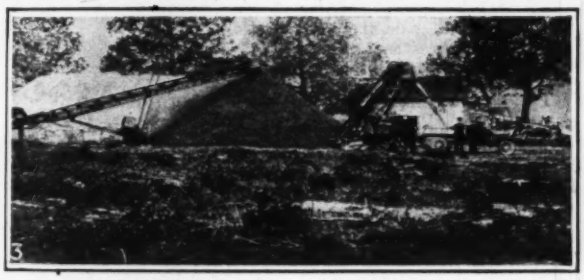


FIG. 3—BUCKET LOADER LOADING FROM STOCKPILE

FIG. 4—CRUSHING COARSE AGGREGATE AND REMIXING

From Job and Office

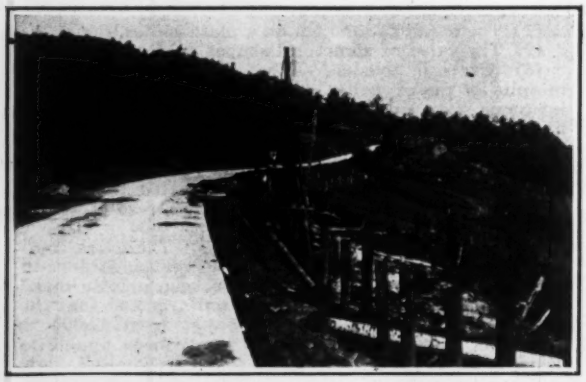
Hints That Cut Cost and Time For the Contractor and the Engineer

Protecting West Virginia Highways From Sliding Hill Damage

Prepared for Engineering News-Record by the West Virginia State Roads Commission

WEST VIRGINIA's rough topography has created a number of knotty problems for road builders. One of these problems, which for some time defied practicable solution, is that of sliding hills. Though disturbing before, with the coming of the motor vehicle, when road users began to demand highways surfaced with something harder than earth, the problem of slipping hillsides became a serious consideration. Hard surfaces are cracked, twisted, warped and otherwise damaged when the earth that supports them moves downward even a foot, while a slip of 50 ft. means ruin. If the state's hard-surfaced roads were to be protected from this ruin the hillside slipping had to be stopped. The problem was by no means a simple one, but the solution has been found.

The first step was investigation. To that end drills were taken to bad spots and holes put down to discover what was beneath the surface. These borings showed



ABOVE: WELL CASINGS BEING DRIVEN INTO SOLID ROCK
BELOW: RETAINING WALL EMBEDDED IN ROCK PUT IN BEFORE ROAD IS COMPLETED

that the center of the hill, in every case, was rock. Above the rock was five, ten or more feet of clay. Between the rock and the clay was a layer of shale, fireclay, or soapstone. Thawing left the top layer of clay porous when the spring breakup came. Melting snows and rains saturated it until it was a mushy, nearly fluid mass. The water seeped down on the intermediate layer, forming a greasy, slippery toboggan down which the clay slowly crept, carrying with it trees, fences, telephone poles, culverts, and highways.

It was first thought that if the intermediate layer could be broken up by blasting, the slippery surface would be destroyed and the seepage water from the clay would go down into the rock beneath. That was tried, but the blasts merely pulverized the "toboggan," the water mixed with it more readily, the whole mass became greasier than before, and sliding was accelerated.

The only alternative seemed to be to build a wall down to the solid rock and heavy enough to resist the presence of the earth above it, but the many walls required, built deep enough and heavy enough to stop a sliding hill, would cost more than any state could afford. It was obvious that some other plan must be worked out. Finally, someone suggested that a light wall anchored to the underlying rock with pipe, filled with concrete, would stop the slides. This plan was tried, and it worked.

In building such a wall, an ordinary well drill, working through a steel well casing, first makes a hole through the earth and 5 ft. into the solid rock. The casing, embedded in the rock, is filled with concrete reinforced with steel rods to form a post nearly as high as the wall is to be. A trench is then dug down to the rock, the wall is built on the rock base, and encases the posts, which anchor it firmly.

More than this is required in some cases, however, to support the great load pressing against the wall, so pipe similar to those described are embedded on the uphill side of the roadway. One-inch iron bars, encased in concrete, connect these uphill anchors with the wall and form an effective tie which prevents the wall from overturning.

Sometimes the concrete posts alone stop the slide and the wall is unnecessary. Many roads of the state have been saved from destruction by this method. As a result of its successful use, the well casing plan has been adopted as the standard method of overcoming such slides as those described.

Materials-Handling Practice on Ohio's "Stage Construction" Highways

BY RAYMOND H. SMITH
Assistant Engineer, Ohio Department of Highways and Public Works, Columbus, Ohio

THE Ohio River road now under construction from the state line west of Cincinnati to Powhattan, Ohio, is 353 miles long. Of this length 124.5 miles are paved; 14.5 miles under construction; 14.5 miles standard grading; "stage construction" complete 134.0 miles; "stage construction" not completed 35.5 miles (14 miles of this is graded); 12 miles of gravel road under maintenance, and 18 miles has not been financed. By "stage

From Job and Office

For Contractor and Engineer

posits exist in many parts of the state, but in those parts where there are no suitable gravel deposits, the cost of this type of construction is high due to railway transportation costs.

The west central part of the Arkansas has many coal mines, and those mines that have been operated for some time have large shale dumps, consisting of the shale that has been separated from the coal at the breaker; there is also a certain amount of fine coal dust. Practically all of these dumps burn by spontaneous combustion and the material in them, after burning, makes a good substitute for gravel as a road surface.

The burnt shale, in most cases, can be obtained for about 10c. or less per cubic yard at the dump, making the initial cost low, as there is usually much less overburden to dispose of than there is at a gravel pit. The shale is loaded in trucks or wagons, either by means of a trap loader or a steam shovel, and hauled to the road where it is placed and spread in much the same manner as is gravel.

After the shale has been placed in the road rolling is not necessary, although of some benefit after the shale has been wet by rains. Constant dragging and smoothing are necessary when the shale is cementing, but if rains occur this cementing period is not long. A burnt shale road is maintained in the same manner as a gravel road, and the wear is only slightly greater than that of a clay gravel surface, although the shale is somewhat dustier than gravel in dry weather.

Where local gravel is available, this type of road is very little, if any, cheaper than a gravel road. However, a given volume of the shale can be hauled more cheaply than the same volume of gravel, because a cubic yard of shale weighs from 2,000 to 2,200 lb., while the average clay gravel weighs about 2,800 or 2,900 lb. per cubic yard.

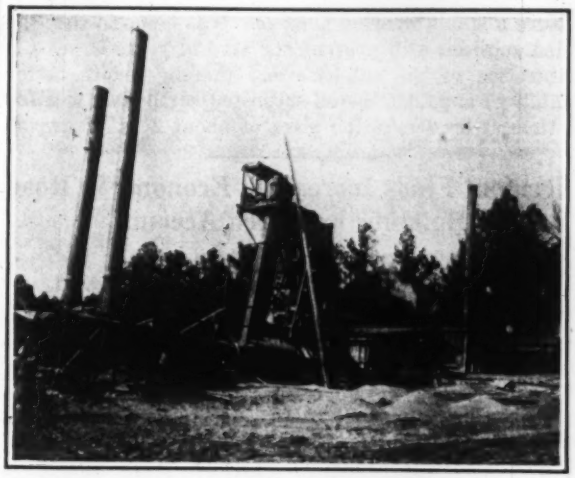
Combustion Chamber Increases Output Asphalt Plant Sand Driers

By C. N. Conner
State Construction Engineer, State Highway Department, Raleigh, N. C.

A DEVICE for increasing the output of sand driers on asphalt plants has been in operation on several plants in North Carolina for over a year. Production on these plants had been held up because the sand driers could not handle the material from wet pits in sufficient quantity to keep the balance of the equipment working efficiently.

The problem was satisfactorily solved by the installation of a combustion chamber placed at the ends of the sand driers. As a result sand from wet pits could be dried better and quicker than so-called dry sand shipped in by rail. This allowed the use of sand from local pits and saved considerable money as well as giving the road surfacing to the public at a much earlier date.

The accompanying photograph shows the combustion chamber in use at a sand asphalt plant which has furnished asphalt for 22 miles of 18-ft. by 4½-in. surfacing between May and December.



PLANT WITH COMBUSTION CHAMBER IN PLACE

The combustion chamber was devised by J. McKay Spears while with North Carolina Highway Commission.

Oiled Sub-Base for Gravel Surfacing

By B. H. Piepmeier
Chief Engineer, Missouri State Highway Department, Jefferson City, Mo.

MISSOURI, along with other states, has been forced to speed up road surfacing. The public is tired of mud roads; and the average motorist wants continuous roads on which he can travel under all weather conditions. To meet this demand with the limited funds made available, many states have been surfacing with gravel from 2 to 6 in. in thickness, with the idea that the surfacing will be thickened or made of higher type as soon as funds are available for betterments. Missouri has in numerous cases surfaced many roads very lightly with gravel. Some soils are of such composition that 3 or 4 in. of gravel are equivalent to 10 or 12 in. in the heavy black loam or adobe soils.

Missouri has on one section of fifteen miles of clay upland soil applied road oil to the sub-base before applying 4 in. of surfacing gravel. The section referred to was first graded and bridged to a 30-ft. roadway, having a crown of 3 to 5 in. The earth surface was then maintained under traffic for a period of at least six months. The surface was then treated with 1 gal. of road oil per square yard over a width of 20 ft. The oil was applied at the rate of about ½ gal. per square yard per application.

A comparatively light road oil, 50 per cent residue, was applied hot for the first two applications. A heavy road oil, 60 per cent residue, applied hot, was used for the last two applications. Five to ten days were allowed to elapse between each application of oil to insure proper penetration. The lighter oils soaked into the sub-base, while the heavier oils formed an oiled blanket. The oiled sub-base was immediately thrown open to traffic, after which 4 in. of high-grade road surfacing gravel was applied. The gravel surfacing was dumped in windrows, after which it was worked into place by maintenance forces. A high-grade bonding gravel is required for such work as the gravel will get no bonding material from the sub-base.

The purpose of the oil application was to cut down on the amount of gravel that would be necessary to

imately 30 ft., where it was placed in 6,000-cu.yd. stockpiles. These stockpiles were located along the road wherever convenient, thus reducing the hauling cost to a minimum. Approximately 175,000 cu.yd. of gravel were thus stored. The gravel was delivered to the upper bank from the bin by 24-in. portable belt conveyors. The primary conveyor was 200 ft. long, was built in 15-ft. sections so that the length could be varied, and was supported by light bents spaced 20 ft. c. to c. The primary conveyor delivered the gravel to second and third portable conveyors, thence to the stockpile. The second and third portable conveyors were moved in circles, thus increasing the size of the storage pile. Each portable conveyor was 45 ft. in length, and each was driven by a four-cylinder gasoline motor. Three men, including the foreman, were required to operate the outfit. It was necessary to move about every ten days. The equipment was then taken down and loaded onto a barge by the clamshell, the barge men helping, one and one-half days being required to take down equipment, load and erect ready for operation.

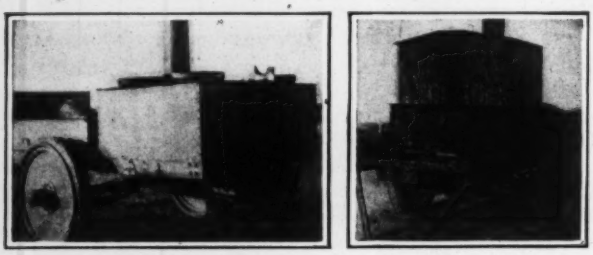
The cost of operation, including depreciation, was 10c. per cubic yard. One of the units was so arranged that the coarse aggregate was screened out and run through a crusher and thence back onto the belt conveyor and mixed with the fine. The metal was reclaimed from the stockpiles with bucket loaders, loading into trucks, though some was reclaimed with a ¾-cu.yd. dragline delivering to a belt conveyor, thence through a 9-in. x 36-in. jaw crusher.

L. A. Boulay is director of highways and public works of Ohio, and G. F. Schlesinger is state highway engineer in charge of the division of highways.

Army Rolling Kitchens Transformed Into Asphalt Heating Kettles

By Leo Ehlinger
Maintenance Engineer, State Highway Department
Austin, Texas

MAINTENANCE of state highways in Texas was taken over by the state highway department Jan. 1, 1924. Prior to that date all maintenance was under the jurisdiction of the various county commissioner's courts. The highway department had no equipment except a considerable quantity of surplus war material secured from the Department of Agriculture. In this equipment were a number of rubber-tired, two-



KITCHEN AT LEFT; HEATING KETTLE AT RIGHT

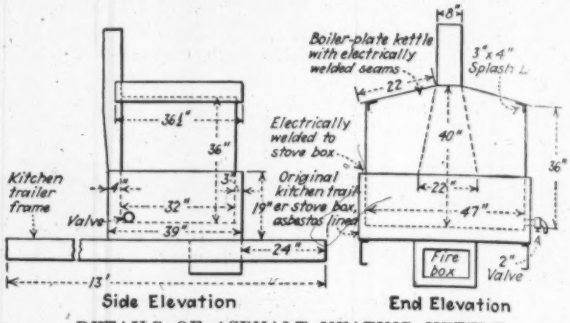
wheeled army rolling kitchens, which apparently were of no use except as trailer chassis.

The maintenance division needed a considerable number of asphalt heating kettles of about 150-gal. capacity, and the idea was conceived of converting the kitchen trailers into asphalt-heating kettles. The heating kettle shown herein was designed.

From Job and Office

Hints that Cut Cost and Time

The kettle was made by cutting off the top of the kitchen stove box, leaving the strap iron pieces riveted in the bottom to rest the kettle on. The box was then moved up to the front of the trailer, the rear cross members was cut out and an angle iron riveted on the



DETAILS OF ASPHALT HEATING KETTLE

end of the trailer frame. From the pieces listed below the kettle was made and placed inside of the box. A piece of sheet steel was then welded around the top as a filler. A hole was cut in the kettle and a sleeve welded in with a screw nipple.

The material required for one kettle was:

2 pieces, ⅛ x 22 x 36½ in.	(lids)
1 piece, ⅛ x 8 x 34½ in.	(top centre)
2 pieces, ⅛ x 40 x 47 in.	(ends)
2 pieces, ⅛ x 32 x 36 in.	(sides)
1 piece, ⅛ x 32⅝ x 47 in.	(bottom)
1 piece, ⅛ x 30 x 44 in.	(stack)
1 2x4-in. black nipple	
1 2-in. wrought-iron sleeve	
1 2-in. cast-iron cutoff valve	
1 2-in. street elbow	
2 pair of 4-in. butt hinges.	

The cost of the completed kettle is as follows:

Freight and handling charge from Department of Agriculture (variable)	$30.00
Materials	32.40
Labor, etc.	22.12
Total cost	$84.52

The kettle shown on the plan will hold about 150 gal. of hot asphalt and requires about one hour to heat to 300 deg. F. Either wood or coal may be used for fuel.

Any standard 1-ton truck has no difficulty in trailing the kettle full of asphalt, with asphalt tools and extra barrels of asphalt in the pan placed in front of the kettle.

The boilers that come with the trailers are removed and used as ice coolers for road gangs.

Burnt Shale as an Economical Road Surfacing

By O. L. Hemphill
Assistant State Highway Engineer, Little Rock, Ark.

MANY of the Arkansas roads do not have sufficient traffic to justify construction of concrete or asphalt pavement at this time, even were sufficient funds available; consequently a large part of the state's new road construction is of gravel. Good clay gravel de-

News of the Week

CURRENT EVENTS IN THE CIVIL ENGINEERING AND CONTRACTING FIELDS

Hoover Sends Governors Traffic Safety Conference Reports

Secretary of Commerce Hoover has addressed a letter to the governor of each state transmitting a copy of the final report of the National Conference on Street and Highway Safety and suggesting that it be called to the attention of the state legislature in the event that new motor vehicle and highway legislation is contemplated. Secretary Hoover is also writing to the mayors of cities as well as to local chambers of commerce, motor clubs and safety councils, calling attention to the recommendations contained in the report and urging co-operation of elements in making them permanently effective locally.

Already the letters received at the offices of the conference indicate that the hundreds of delegates to the conference have begun, with the assistance of the newspapers of the country, to wage a more intensive drive for safety education and safety practices. It is also indicated that railway officials, motor clubs, chambers of commerce, safety councils and other bodies are being brought into close contact with the work undertaken by other groups. The support of all these groups, it is shown, will be given wholeheartedly to programs which may be undertaken by officials in the various states and communities for reduction of accidents.

The recommendations adopted by the conference are being prepared in the form of a printed report, which will be made available for the information and assistance of official and non-official organizations.

Pledges of the co-operation of two important organizations have been received, one from the American Legion, with its 17,000 posts and auxiliaries, and the other from the National Association of Commissioners for Uniform Laws.

Accident on the Soo Line Causes Eight Deaths

Derailed by a broken switch rail on the approach to the Chippewa River bridge of the Soo Line at Chippewa Falls, Wis., on Dec. 19, the rear car of an eastbound passenger train reached the bridge with its wheels outside the guards along one side of the deck. The displacement broke or disconnected the coupler and the car went head-first off the bridge, its rear end remaining above the water. To lower the water level the gates of the Wissota Dam, three miles upstream, were closed. By means of boats and by ladders lowered from the bridge many passengers were rescued, but eight persons were killed and several were injured. On the bridge, which has deck trusses and is about 60 ft. high, the floor has outside guard timbers and inside guard angles.

Engineering News-Record is a consolidation of *Engineering News* and *Engineering Record*, effected in 1917.

Engineering News was founded in 1874 by George H. Frost, as the *Engineer and Surveyor*, which title subsequently became the *Engineer, Architect and Surveyor*, then *Engineering News and American Railway Journal* and finally, *Engineering News*, under the successive editorships of D. McN. Stauffer, Arthur M. Wellington and Charles Whiting Baker.

Engineering Record was established in 1877 by Henry C. Meyer as the *Plumber and Sanitary Engineer*. The name was subsequently changed to the *Sanitary Engineer, Engineering and Building Record* and, finally to *Engineering Record*. During his ownership of the paper, Mr. Meyer was directly responsible for the editorial policy. John M. Goodell became editor in 1902, and was succeeded by E. J. Mehren.

The Contractor was consolidated with *Engineering News-Record* in 1918.

E. J. Mehren became editor of *Engineering News-Record* at the time of the consolidation in 1917, and was succeeded by Frank C. Wight, Jan. 1, 1924.

The staff of *Engineering News-Record* consists of

New York: Frank C. Wight, *Editor;* M. N. Baker, F. E. Schmitt, R. K. Tomlin, Jr., C. S. Hill, J. W. Shaver and Van Tuyl Boughton.

Chicago: W. W. DeBerard, E. E. R. Tratman.

San Francisco: N. A. Bowers.

Toronto's $28,476,000 Viaduct Agreement Signed

After years of discussion the agreement for the construction of the viaduct along the water front at Toronto, Ont., has been signed by the contracting parties and approved by an order-in-council. The agreement now needs only the formal approval of the Board of Railway Commissioners, which is expected within the next few weeks, before the tenders for contracts can be called for. It is expected that work on this project will start sometime in April.

Large Dam Projected in Quebec on Gatineau River

It is expected that legislation will be introduced at the coming session of the Quebec Legislature providing for the construction of a dam on the Gatineau River, at a point known as Lake Cadonge, in the upper part of the river. The cost of the enterprise is estimated at close to $1,000,000.

Regional Planning Conference for N. Y. Capitol District

A conference to consider regional planning for the counties of Albany, Schenectady and Rensselaer, N. Y., will be held at the Albany City Hall on Jan. 6. Invitations have been sent to the mayors of Albany, Schenectady, Troy, Cohoes, Rensselaer, and Watervliet and to the presidents of all the villages in the three counties. The conference has been called by the State Commission of Housing and Regional Planning, which is making a study of the resources and trends of development in the state as a whole. Among the members of the commission are Sullivan W. Jones, state architect; Arthur W. Brandt, commissioner of highways; and Clarence S. Stein, 949 Broadway, New York City, chairman. Mr. Stein, in inviting the public officials to this conference stated: "The development which will come with the deepening of the Hudson River and the creation of a port in the Capitol district area demands co-operative action by the municipalities and county governments within this region, in planning for future growth along the broadest lines."

Program of Drainage Congress Tentatively Arranged

A tentative program of the National Drainage Congress, to be held at the Auditorium Hotel, Chicago, Jan. 5 to 7, assigns the general subjects as follows: Jan. 5, morning, tile drainage; afternoon, drainage legislation; Jan. 6, morning, waterways and flood control; afternoon, drainage and irrigation methods; Jan. 7, morning, land colonization; afternoon, land management.

Among the technical papers on the program are the following: "Tile Drainage Systems," C. G. Elliott; "Drain Tile Costs," J. W. Dappert; "Needed Legislation," E. V. Willard; "State Organizations for Drainage Legislation," Prof. E. R. Jones; "Iowa's New Drainage Law," W. J. Schlick; "Conservation Commissions," M. J. Stinchfield; "Flood Control in the Mississippi Valley," John W. Alvord; "Silting and its Control," L. L. Hidinger and R. N. Towl; "Hydraulic Power and Flood Control," C. F. Jacoby; "Reconstruction of Old Drainage Districts," C. E. Young; "Research in Strength and Flow of Pipes," C. D. Lenth and D. L. Yarnell; "Pumping District Design Methods," J. A. Harman; "Private Irrigation Systems," G. E. P. Smith; "Assessments," G. A. Boyd.

A business meeting, with election of officers, will close the meeting. C. E. Young, consulting engineer, Muscatine, Iowa, is president of the National Drainage Congress. The secretary is C. R. Thomas, Monadnock Block, Chicago.

insure a stable wearing surface. It is believed that the oiled sub-base will prevent for several years at least a saturation of the sub-base and thereby insure better stability; and that the oil-saturated earth base will for a time at least take the place of about 2 in. of gravel.

Vermont Finds Increasing Economy in Road Building by Force Account

By Thurman W. Dix
Chief Engineer, State Highway Board, Montpelier, Vt.

An important development in road building in Vermont during the past year has been a departure from contract to force account work on the larger jobs. Vermont's road work since its beginning in 1892 has consisted almost entirely of small jobs where funds available for any one job (town money and state aid), seldom exceeded $1,000 to $2,000. These jobs have been essentially town work where the state appointed the foreman, the town paid for the work as it was being done and was reimbursed by the state for a portion or all of the cost upon an approved claim. The work was done in practically all cases by local men and by force account. With the advent of federal aid, funds in larger amounts for any one job were made available and most of the federal-aid projects have been done by contract. As a general rule, the highway department has favored doing this work by contract and doubtless would now if its experience with contract work and contractors had been more satisfactory.

The chief reason for the departure from contract to force account work has been that the contractors' bids were too high. This occurred where ten or more bids from good contractors were received and where bids were received at two different times, showing that there was apparently good competition.

Other reasons have been:

(1)—Contractor abandoning contract, leaving an unfinished job.

(2) —Contractor unable to complete contract.

(3)—Contractor making too slow progress.

In all cases where jobs have been attempted by force account after bids have been received and rejected because they were too high, a saving of from 20 per cent to 33 per cent has been effected. In all cases where jobs were let by contract and abandoned or taken over by the state, the work has been completed practically within contract prices and in one case at a saving of 15 per cent. Contracts are seldom abandoned and taken over except where the contractor is losing money. To complete such contracts at contract prices is sufficient to commend the method but to effect a saving of 15 per cent should command attention.

The above percentages are savings between actual cost by force account and contract prices and not estimated prices. Actual cost by force account includes all charges which could properly be charged to the job, and no expense incurred was charged to any other account. Actual cost includes small tool rentals and machinery rentals or depreciation charges sufficient to pay for same well within the life of the equipment.

The savings are due primarily to better management on the part of the state, resulting in more effective work and a large reduction in overhead. Of course, the state has no bond premium to pay, no workmen's compensation and employer's liability, and no interest on borrowed money to finance the job.

Earth Road Maintenance in Iowa

By W. H. Root
Maintenance Engineer, Iowa State Highway Commission
Ames, Iowa

Proper maintenance of earth roads requires proper organization and equipment just as first class maintenance of any other type of road requires the right kind of men and tools. The organization and equipment for earth maintenance, however, cannot be standardized as completely as for most other types. Gravel roads for example are usually built under similar specifications both as to materials and methods and the results, therefore, are more or less uniform products that can be maintained in a more or less uniform way. Earth roads on the other hand are not built to standard specifications so the resulting product is not uniform.

The equipment used in earth maintenance is important. The class of equipment varies, however, both with the kind of soil and the amount of traffic. Light two- or four-horse patrol graders do satisfactory work on light soils but are practically useless on heavy soils. For the maintenance of heavy soil roads, especially if they carry heavy traffic, the most useful tool is the heavy blade machine. The ordinary four-horse drag and various heavier power maintainers will be found useful under different conditions but in all cases liberal work with the big blade will be advantageous.

But of still greater importance than the right kind of tools, is the right kind of men. Earth maintenance men must be high-class fellows. They must be endowed with "good road sense" and must have indomitable courage. They should take pride in their work but never be satisfied. Earth road maintenance is a continuous performance. It is also a largely unappreciated work. A good patrolman should not be discouraged after spending six days polishing the surface of an earth road if on the seventh day it rains and the "pride of his heart" becomes a nightmare. Neither should he resent it if in such a case the traveling public berate him loudly because the road is not in good condition for their Sunday afternoon spin.

Ample men and equipment should be provided in all earth maintenance organizations to drag the surface once completely, in from six to eight hours. Most heavy soils will not be in shape to maintain before 10 a.m. or possibly noon the day following the rain. A sufficient force should be available to start in at that time and complete the dragging of the whole system before quitting work that night. This should be done even if it requires evening work. At the very best, summer rains will cause two days of inconvenience to the traveling public: one day of rain and one day of drying and dragging. In the fall and spring seasons, when drying is slower, this period may be three or four days. The reducing of this period of inconvenience to an absolute minimum should be one of the first concerns of any maintenance organization. A great deal of just criticism has been leveled at maintenance forces, generally due to the fact that the maintenance work has not been promptly done after rains.

In conclusion then, pick good men and give them equipment adapted to the soil and traffic conditions with which they will have to contend. Do not overlook the benefits derived from supplementary work with heavy blade machines. Emphasize prompt maintenance after rains and continuous maintenance between them.

William P. Blair Dies

William P. Blair, vice-president of the National Paving Brick Manufacturers Association and its organizer, died at his home in East Cleveland, Ohio, Dec. 23, aged 76 years.

Mr. Blair was educated at Erlham College, Richmond, Ind., and for some time after graduation studied and practiced law. He early became interested in the use of brick as a paving material, himself engaging in its manufacture. Interested in the good roads movement Mr. Blair soon became known for his work in connection with the study of subsoils and their bearing power. He was a pioneer in the belief that adequate drainage was one of the prime considerations in the design and construction of a permanent road structure.

Mr. Blair organized the National Paving Brick Manufacturers almost a quarter of a century ago and had devoted his time since then to the proper design and construction of all pavements, particularly vitrified brick pavements. He had attended the recent meetings in Washington of the Advisory Board on Highway Research and at Columbus of the Ohio Good Roads Federation.

Mr. Blair was a member of the Cleveland Engineering Society, a past-president of the Cleveland Chapter of the American Association of Engineers, member of the International Road Congress, American Road Builders Association, American Society for Municipal Improvements and the American Society for Testing Materials, as well as a member of the state engineering societies of Ohio, Illinois, Indiana, Wisconsin, Michigan and Iowa.

Engineers to Study Forestry

Studies of the forestry situation in the various states will be made by national and local engineering societies under the direction of the American Engineering Council, which announces its purpose of working with the federal government to carry out the provisions of the Clarke-McNary Act.

The nation's timber resources are thinning so rapidly as to constitute a grave social and industrial menace, according to the Council, which at a forum in Washington, D. C., Jan. 16-17, attended by delegates from all over the country, will plan a nationwide reforestation effort, the building industry and other agencies co-operating.

The Council has appointed a committee on reforestation, which has already begun the work of enlisting engineers in every state in a permanent organization whose investigations will harmonize with a federal policy, according to the president of the Council, Ex-Governor James Hartness.

A survey has disclosed that fourteen states are without forest departments. The most heavily timbered of these are Florida, South Carolina, Georgia, Mississippi, and Arkansas.

Transportation Council Suggested for New England States

Decision to set up a New England transportation council was made by the 400 or more delegates attending the New England motor transport conference at Boston on Dec. 8 and 9. This new council will include representatives of railroads, trolley lines, motor truck and motor bus interests, and the public, following the precedent set in forming the resolutions committee for the New England conference. While importance is attached to numerous addresses by those representing all elements in the transportation field in New England, perhaps the most valuable work of the conference was the passing of resolutions setting forth principles which guide the use of the highways of the country by commercial vehicles.

Upon motion of C. L. Bardo, general manager of the New York, New Haven & Hartford R.R., store-door delivery was endorsed in a resolution which asserts that "the motor truck interests in the several localities of heaviest traffic should appoint committees to act with similar committees appointed by the railroads to make a comprehensive and unbiased study of the problem." Regulation of the common-carrier motor by some state authority charged with the task of providing the public with needed transportation was suggested by another resolution which was passed.

Work Again Under Way on Hetch Hetchy Project

Work on the mountain division of the Hetch Hetchy project, which was closed down when 500 men were laid off on Dec. 8, was resumed on Dec. 23 and full crews are now working in all camps. The differences in the San Francisco city hall over the financing of this work were reported in a note appearing in *Engineering News-Record*, Dec. 18, p. 1010.

Despite the remonstrances of the city engineer's office the final decision of the board of supervisors was to replenish the Hetch Hetchy fund from outside sources; the plan to accept $1,000,000 advance interest from the Spring Valley Co. was adopted and then the work was resumed.

Southern Pacific to Close Gap in Arizona

With the award of a contract to C. E. Crowley of Los Angeles for grading 50 miles of the new line between Picacho and Chandler, Ariz., the Southern Pacific R.R. is starting operations that will close up the gap in the existing system between Tucson and Phoenix.

It is understood that the work yet to be done west of Phoenix, to complete the new line between Phoenix and Yuma, will not be undertaken until the work mentioned in the foregoing is completed.

New Am. Soc. C. E. Secretary Assumes Office

George T. Seabury, the new secretary of the American Society of Civil Engineers, takes over the duties of that office today, Jan. 1.

Mr. Seabury was elected at a Board of Directors meeting in Pittsburgh.

Mr. Seabury is a civil engineering graduate from the Massachusetts Institute of Technology and has had a long and varied experience in water-supply work both in New York and New England. During the war he served as a major in the Construction Division.

Since March, 1923, Mr. Seabury has been manager of the Providence (Rhode Island) Safety Council.

To Investigate Power Brakes

The American Railway Association has announced the completion of its plan for an exhaustive investigation of power brakes and the appliances for operating power brake systems to be made under the auspices of competent and independent experts. The cost of the investigation will be borne by the American Railway Association. The work will be in charge of Harley A. Johnson, assistant general manager of the Chicago Rapid Transit Ry. as director of research, and the tests will be made on the test track at Purdue University, Lafayette, Ind., which track will be completely overhauled and brought up to date for the purpose of this investigation.

The work is the outgrowth of an effort of the Bureau of Safety of the Interstate Commerce Commission to determine whether the present system of air brakes as used in our train service cannot be improved upon.

Crosstown Highway in Detroit Practically Assured

A jury has brought in a verdict fixing an award at $4,472,844 involving 385 claims along the proposed Dix-High-Waterloo crosstown highway. The amount covers necessary demolition to widen the highway. This verdict is considered the first step towards superhighways in Detroit. It will provide a route for east and west traffic keeping a large percentage of vehicle away from the congested downtown section.

The route for the highway runs from the easterly city limits at Waterloo Avenue to the River Rouge plant of the Ford Motor Co. For the greater distance the highway will be 80 ft. wide and it is recommended by the jury that a certain section be made still wider. The jurors also recommended that in view of the general nature of the improvement, the council be generous in the matter of apportioning the assessment, and that the greatest width of pavement possible on this street should be provided as early as possible.

Jewish Engineers Organize

A group of engineers, with Lazarus White as chairman, Leon Moisseiff as vice-chairman and an executive committee consisting of James J. Jacobs, Abraham A Rosenzweig, Isaac J. Stander, S. Levinson and N. Cohen have organized for the purpose of interesting the Jewish engineers throughout the country in the $1,000,000 drive for the Ort reconstruction fund.

The Ort reconstruction fund, which is being raised under the auspices of the Association for the Promotion of Technical Trades and Agriculture among the Jews, will be used for loans to Jewish farmers and artisans in Eastern Europe and for the support of the technical trade schools maintained by the organization. There are at present 84 such schools in existence, in addition to evening courses for adults, model workshops, etc. One of these—the Wilna Technical High School—is the only one of its kind in that part of Europe. The movement toward technical trades among the Jews of Poland, Lithuania, Latvia, Roumania and Russia has been given a tremendous impetus by the new economic orders, which have practically done away with shopkeeping and similar occupations.

Texas School for Filter Plant Operators Opens Jan. 26

The seventh short school for filter plant operators, given under the auspices of the Texas Section of the Southwest Water Works Association in cooperation with the University of Texas, will be held at Austin, Jan. 26 to 31.

George W. Fuller, consulting engineer of New York City; Wynkoop Kiersted and N. T. Veatch, Jr., consulting engineers of Kansas City; representatives of the National Board of Fire Underwriters; members of the University of Texas engineering faculty; consulting engineers and water-works officials over the state are scheduled to deliver papers. The University of Texas will supply a staff of lecturers and its laboratories for the first three days of the meeting, which will be devoted entirely to the solution of technical problems of operators. The remaining three days have been designated as operators and designing engineer's day, water commissioner's day and convention day, to include such general discussions of subjects as will be of interest to the entire meeting.

The secretary of the school is V. M. Ehlers, chief of the Sanitary Engineering Division of the Texas Board of Health.

Lowell Water Department Survey Voted by Service Board

The Board of Public Service of Lowell, Mass., has voted to have a survey of the Water Department made by Robert J. Thomas, who was superintendent of the local water-works from 1892 to 1919, Arthur T. Safford, engineer, Proprietors of Locks and Canals, and Stephen Kearney, city engineer, the work to be in charge of the latter.

Engineering Bodies to Study Industrial Situation

Alfred D. Flinn, director of the Engineering Foundation, has announced that a nationwide investigation enlisting 20 agencies, is about to be made under the auspices of the Foundation and the National Research Council of means whereby a greater happiness, and increased efficiency and productivity may be promoted among the workers. The chief aim of the investigation will be a study of the abilities, training and economic needs of men and women, their conditions of work, incentives, rewards, and opportunities for growth and advancement.

Organizations sharing in the study, according to the announcement, include the National Research Council, Engineering Foundation, American Federation of Labor, Bureau of Vocational Information, Vocational Service for Juniors, Department of Industrial Research at the University of Pennsylvania, Graduate School of Business and the Bureau of Vocational Guidance at Harvard University, National Committee for Mental Hygiene, U. S. Public Health Service, U. S. Bureau of Labor Statistics, U. S. Bureau of Mines, U. S. Civil Service Commission, Research Bureau for Retail Training at the University of Pittsburgh, School of Business Administration at the University of Chicago, and departments active in personnel research at Dartmouth College, Bryn Mawr College, Northwestern University, University of North Carolina, University of Michigan.

Engineering Fifty Years Ago

From *Engineering News*, January, 1875

THE year just closed has been a season of "hard times" for American engineers and surveyors. The general cessation of railroad construction, and of city and suburban improvements, that followed the financial panic of 1873, was, to very many of them, the beginning of a period of forced inactivity, the end of which is still indeterminate, while to many more it greatly reduced the demand for their services and correspondingly diminished their incomes. But civil engineers are familiar with intervals of "nothing to do;" they are not infrequently obliged to suffer the loss of their earnings by the failure or dishonesty of the individuals or corporations employing them; they are often exposed to sickness and disease, and are otherwise subjected to the ordinary ills of life; they are usually, however, men of more than average intelligence, and possessed of large practical ability; apt to devise and prompt to execute expedients to meet every emergency. We believe, therefore, that the great body of the engineering profession of this country are, at the present writing, better prepared to await, with a contented philosophy, the return of better days, than are our debt-burdened merchants, manufacturers and speculators.

Random Lines

Secondary School Competition

A letter from a high-school teacher to the "Head of Engineering Department, University of Illinois," reads:

"We are trying to organize a night class in Janitor Engineering, and I am asking for your personal opinion in regard to the text-book for same."

* * *

Strange Bedfellows

BOOTLEGGERS—ENGINEERS—OIL MEN

Choose Firestone Tires

The precarious existence of the first class necessitates dependable tires.

The technical training of the second class will admit of no article unless mechanically perfect.

The oil man has no patience with any article unless it gives thorough and exacting service.

Says a correspondent about the above advertisement in the *Inland Oil Index*—"This seems to provide for the engineer a new place on the social ladder. I am not satisfied with the middle place for the engineer but I have not as yet made up my mind whether the profession should be ranked at the head or the tail end."

* * *

Another Illegal Brother

"Some of our rich are such amateurs. They really should take lessons from professional smugglers. No doubt some practiced border runner could build up a lucrative business as 'Smuggling Engineer.' How the would-be defrauders of Uncle Sam would flock to him for guidance! And whenever the income from his clients was not satisfactory, he could arrange to double-cross them, the way the French jeweler did the New York woman who was recently caught trying to get $60,000 worth of gems into the country." Boston *Traveler*.

* * *

Solving the Sludge Disposal Problem

"The Smokador ashless ashstand is a wonderful piece of sanitary engineering."

* * *

More on the Engineer's Status

Some New York engineers were seated around a club luncheon table the other day when, in a lull in the conversation, one of them said:

"By the way, do you know anyone looking for a job? There was a man in my office this morning who wanted an engineer to fill a job he had. Said it would pay $12,000 a year. . . ."

"How much," asked one of the engineers.

"$12,000 a year."

"Just a moment, gentlemen," said the second man. "Just a moment. I propose as a matter of common fairness that we all line up here at the table and start even."

Power for Illinois Central Electrification

Another step in preparing for electric operation of the Chicago terminal lines of the Illinois Central R.R., is the signing of a 10-year contract for electric current, under which the Commonwealth Edison Co. will build seven substations on the main line and the Blue Island and South Chicago branches. The suburban service is to be in electric operation in 1926, after which will come the operation of main line service on the 28-mile stretch within the terminal district.

Company Cannot Be Made to Supply Free Water to Schools

A city ordinance of Alton, Ill., requiring the Alton Water Co. to supply water to the public and parochial schools of that city was held invalid by a State Supreme Court decision on Dec. 16. The court held that the City of Alton and the Board of Education are separate corporate entities; that the Board of Education has no power to levy a tax for maintaining a waterworks system nor has the city authority to levy a tax for schools.

Committee on Sewage Treatment for New York City

A committee on main drainage was appointed on Dec. 19 by the New York City Board of Estimate and Apportionment, to consider all sewage-disposal matters of interborough interest. The committee consists of the five borough presidents and Arthur S. Tuttle, chief engineer of the board just named. The creation of the committee is in line with recommendations made by Mr. Tuttle in a report on the sanitary condition of the waterfront and harbor of New York City in which, and in a detailed supplementary report by Kenneth Allen, sanitary engineer of the board, there are reviewed the sanitary conditions of the waters in question and the steps already taken and proposed to counteract sewage and oil-waste pollution. in concluding his report Mr. Tuttle stated:

"I am of the opinion that undue haste in the development of plans for the treatment of New York sewage beyond the needs as they develop from time to time would be unwise from an economic standpoint. The refined methods of sewage treatment which are recognized today are more particularly aimed at conditions where the purity of waters used for drinking purposes is involved, and would require the setting aside of large areas or the creation of incidental nuisances, the former of which conditions will be difficult to fully meet in some sections of the waterfront, while the latter is manifestly one to be avoided.

"It is my belief that the problem of treating sewage under conditions such as obtain in New York Harbor, where it could not be presumed that safe bathing conditions can be maintained other than at the ocean beaches or that the shell-fish industry can be properly protected, is open to extended research."

Engineering Societies

Calendar

Annual Meetings

NATIONAL DRAINAGE CONGRESS, Chicago, Ill.; Annual Convention, Chicago, Ill., Jan. 5-7, 1925.

AMERICAN ROAD BUILDERS ASSOCIATION, New York City; Annual Convention, Chicago, Ill., Jan. 5-9, 1925.

ASSOCIATED GENERAL CONTRACTORS OF AMERICA, Washington, D. C.; Annual Meeting, Washington, D. C., Jan. 12-14, 1925.

AMERICAN ENGINEERING COUNCIL, Washington; Annual Meeting, Washington, D. C., Jan. 16, 17, 1925.

AMERICAN SOCIETY OF CIVIL ENGINEERS, New York City; Annual Meeting, New York City, Jan. 21-23.

ENGINEERING INSTITUTE OF CANADA, Montreal; Annual Meeting, Montreal, Jan. 27-29, 1925.

AMERICAN WOOD PRESERVERS ASSOCIATION, Chicago, Ill.; Annual Meeting, Chicago, Ill., Feb. 3-5, 1925.

AMERICAN CONCRETE INSTITUTE, Detroit, Mich.; Annual Meeting, Chicago, Ill., Feb. 24-27, 1925.

AMERICAN RAILWAY ENGINEERING ASSOCIATION, Chicago, Ill.; Annual Convention, Chicago, Ill., March 10-12, 1925.

AMERICAN WATER WORKS ASSOCIATION, New York City; Annual Convention, Louisville, Ky., April 27 to May 2, 1925.

The Minnesota Federation of Architectural & Engineering Societies holds its annual convention Jan. 23 and 24, 1925, at the Curtis Hotel, Minneapolis, immediately following the convention of the Minnesota Surveyors' and Engineers' Society, Jan. 22, 23.

The Indiana Section of the American Water Works Association, formerly the Indiana Sanitary and Water Supply Association, meets Jan. 22 and 23, in Indianapolis. Fire service, stream flow and water power, economies of electrical pumping, large consumer service, night pumpage and deep well maintenance are topics on the program.

The Contractors' Association of Northern California held its annual convention at San Francisco Dec. 12 and 13, with a representative group of road builders in attendance. Sessions extended over the two days with the annual banquet on Friday night and a theater party on Saturday night. Legislation, insurance and indemnity problems and ways and means of eliminating irresponsible bidders were topics prominent in the discussions. Because of the large attendance of members and guests at the banquet, that occasion was chosen for three important addresses which were made by R. M. Morton, chief engineer, California State Highway Commission, William B. Joyce, chairman of the board, National Surety Co., New York, and G. LeR. Stevick, vice-president, Fidelity and Deposit Co. of Maryland, San Francisco. Officers elected for 1925 are: President, Henry J. Kaiser; vice-president, W. J. Wilkinson; manager, Fred G. Simmons, and secretary, Earle G. Lloyd.

Personal Notes

JOHN L. VOGEL has resigned as bridge engineer of the New Jersey State Highway Commission to become bridge engineer for the Lackawanna Railroad Co., effective Jan. 1. Mr. Vogel, who lives at Manasquan, N. J., was formerly assistant bridge engineer for the Central Railroad of New Jersey for ten years. He has been in charge of bridge work for the highway department involving recently an expenditure of approximately $3,000,000.

JAMES E. SHELTON, who has been connected with Mobile County, Alabama, in various capacities for several years and who has recently been temporarily filling the position of county engineer since the resignation of A. C. Holder, has been appointed county engineer.

C. B. LEWIS, chief engineer of the North Western Expanded Metal Co., Chicago, has resigned, and will spend several weeks traveling in the south before forming other plans.

Obituary

OLAF HOFF, consulting engineer, New York City, who devised the floating caisson method of tunnel construction used on the Michigan Central R.R. tunnels between Detroit, Mich., and Windsor, Canada, died Dec. 24, at Montclair, N. J., aged 65 years. Mr. Hoff was born in Norway and, after elementary education in the Realgymnasium at Ringerike, Norway, went to Christiania where he graduated in civil engineering from the Polytechnic Institute. He came to the United States and in 1880 entered the services of the Keystone Bridge Co., of Pittsburgh. The following year he became engineer of bridges for the Mexican Central Ry. and later engaged with the Shiffler Bridge Works as designing engineer. In 1901 Mr. Hoff became engineer in charge of bridges and buildings of the New York Central and Hudson River R.R., and four years later became a member of the contracting firm, Butler Brothers-Hoff Co. In recent years he has been in consulting practice in New York City. The Detroit River tunnel project was launched in 1875, then abandoned, and carried through in 1908 under the method devised by Mr. Hoff, which placed him in the ranks of the leading engineers of the country. In 1891 he built the bridge across the Mississippi River at Minneapolis. During his service with the New York Central and Hudson River R.R. he was identified with the renewal and reconstruction of more than 400 bridges. He was one of the engineers who constructed the four-track tunnel carrying the Lexington Avenue tunnel under the Harlem River in New York City.

From the Manufacturer's Point of View

A Point of Contact Between Maker and User of Construction Equipment and Materials

Increased Production Boosts Paving Brick Stock

Increases in production and stock on hand with slight decreases in shipments and unfilled orders due to seasonal influences are reported in the paving brick industry, according to figures just prepared for the U. S. Department of Commerce by the National Paving Brick Manufacturers Association for the month of November. Twenty-two companies representing 61 per cent of the normal tonnage capacity of the industry reported plants running at 89 per cent of their normal monthly capacity.

Production for November was 27,078,000 brick as compared with 26,294,000 for October. Shipments declined from 29,142,000 in October to 22,833,000 for November. Stock on hand was increased from 73,604,000 in October to 73,846,000 in November. Unfilled orders the last day of November stood at 68,673,000 as compared with 88,638,000 the last day of October.

Business Notes

EAST IRON & MACHINE CO., Lima, Ohio, through its president and general manager, C. C. Mosher, has announced new features for the Merriman car plant for mixing asphalt. A 1-ton batch mixer, driven by a 40-hp. engine, has been substituted for the 1500-lb. mixer driven by a 30-hp. engine formerly used. This change, the manufacturer states, adds 30 per cent to the capacity of the plant without materially increasing labor costs.

TENNESSEE TOOL WORKS, INC., Knoxville, Tenn., has recently appointed the following distributors for its Ault traffic line marking machine: For North Carolina, South Carolina and Virginia, the General Utilities Co., Norfolk; for eastern Pennsylvania, Delaware and southern New Jersey, the Interstate Machinery Corporation, Philadelphia; for northern New Jersey, southern New York, and Connecticut, the William R. Wilson Co., New York City; for Illinois and Wisconsin, the Servicised Products Corporation, Chicago.

WESTINGHOUSE ELECTRIC & MANUFACTURING CO., East Pittsburgh, Pa., reports a substantial increase in the power transformer business for November, with sales for the month exceeding one-third of a million dollars, exclusive of orders calling for less than $50,000 worth of equipment. Four important orders, aggregating $353,000, were received from the Pacific Gas & Electric Co., the Central Georgia Power Co., Ford, Bacon & Davis, and the Arkansas Light & Power Co.

Equipment and Materials

Developments in Road-Building Machinery

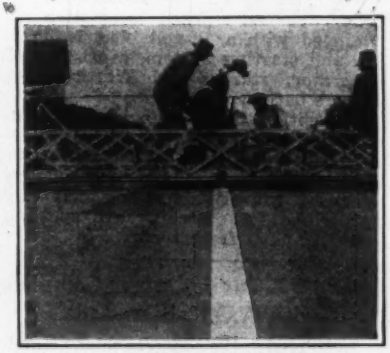
For this, the Annual Highway Number of "Engineering News-Record," preceding the convention of the American Road Builders Association and the Good Roads Show in Chicago, Jan. 5-9, the following descriptions relate to equipment of interest chiefly to road-building contractors and highway engineers. Additional material on improved machinery for road construction and maintenance will appear next week and in the Convention Report Number of Jan. 15, carrying a detailed story of the Good Roads Show—Editor.

Machine Builds Traffic Guide Line Into Pavement

With a machine just placed on the market it is possible to build into a concrete pavement a strip of white

Scraping concrete from channel

Floating white cement strip



Completed Traffic Line

cement forming a permanent traffic guide line for vehicles. The machine, designed by J. N. Heltzel and distributed by the newly organized Flexible Road Joint Machine Co., 470 Hanna Bldg., Cleveland, Ohio, consists essentially of a latticed steel bridge spanning the pavement slab and carrying midway between its ends a pair of steel cutter blades 12 ft. long extending parallel to the center line of the roadway. These cutter blades are adjustable laterally and may be spaced 2, 3, 4 or 5 in. apart, depending on the width of the traffic line desired.

The first step in forming the traffic line is to force the cutter blades about ½ in. into the concrete surface and then with a tool in the form of a sharp blade to rout out the concrete along the line to a depth of about ½ in. The blades on either side prevent the concrete from the adjacent road surface from slumping into the channel thus formed.

With the cutters still in place and the channel scraped out, leaving a rough surface for bonding, a mixture of 1 part white portland cement, 1½ parts coarse sand, and 3 parts of gravel or crushed stone, ¼ to ¾-in. screen, is placed in the channel and struck off flush with the road surface with a tool which fits between the blades. The blades are then raised, the machine moved forward and the operation repeated. The cutter blades are so designed that they may be curved horizontally to conform with the road alignment.

The advantage of this permanent traffic line, according to its manufacturer, is that it requires no maintenance, as is the case with painted lines which wear out.

Improvement Made in Concrete Road Tamper and Finisher

An improved model of concrete road tamper and finisher has recently been developed by the Dunn Road Machinery Co., Conneaut, Ohio, and tried out on state highway construction work. The machine is powered with a two-cylinder 8-hp. LeRoi gasoline engine, has traction

speeds forward of 8 ft. per minute and reverse 30 ft. per minute, is equipped with a roller chain drive, and performs four operations: (1) striking off; (2) tamping; (3) screening; (4) finishing with belt. The operator can throw all four operations into action at one time or any one or any combination of the four. The equipment is manufactured to finish half-width or full-width roads, and is made in 16, 18 and 20-ft. sizes.

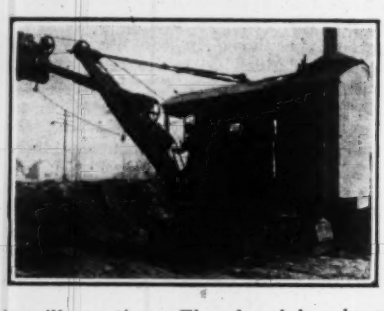
The construction consists entirely of steel shapes and high grade castings with all high-speed bearings bronze or babbitt lined. The strike-off, driven transversely through a crank and connecting rod with a variable stroke, is adjustable for crown and elevation. The tamper is driven by five eccentrics and has an adjustable stroke for varying the pressure instantly as required for wet or dry concrete. The finishing screed is formed to the exact road contour and when in operation rests on the road forms. It has a 5-in. transverse

stroke and, being comparatively light in weight, is used only for smoothing the surface to the required shape and ironing out rolls and depressions. The belt has a transverse stroke and gives a final finish to the road surface.

All controls are within easy reach of the operator who rides on the machine and has a complete view of the work as he travels over it. A transport truck is provided for moving the finisher from one location to another.

New Power Shovel on Market

A new steam shovel has just been placed on the market. It is a ¾-yd revolving type machine, mounted on crawlers, as shown in the accompanying illustration. The shovel has been named the Massillon and is manufactured by Russell & Co., Massillon, Ohio, builders since 1842 of heavy steam and internal combustion engines.



Control Improved on Power Shovel, Crane and Dragline

The Northwest Engineering Co., builders of cranes, shovels and draglines, has added to the new "feather-touch" lever control, the device which shifts the clutches through the power of the engine, as described in this journal Sept. 4, p. 401, a new arrangement of controls designed to increase the capacity of the machine by bringing greater comfort to the operator.

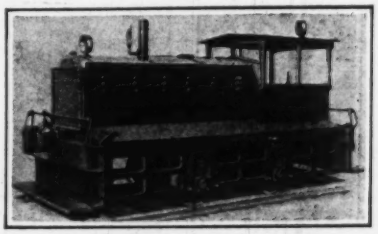
A comfortable metal seat which folds out of the way when not in use is provided, the arc of the levers is shortened, reducing the length of the pull, and the pedals work in and out like the clutch and brake of an automobile, and not up and down as is the usual practice.

Special attention has been given to the pedals. They are wide and comfortable to the feet and grooves reduce slippage. The angle at which they are placed permits the operator to remain seated; he never has to rise partly and stand on the small pedals. The entire control of the machine including steering is had from the seat.

New 15-Ton Gasoline Locomotive

The latest addition to the line of gasoline locomotives manufactured by the Milwaukee Locomotive Manufacturing Co. is a 15-ton machine furnished for all track gages from 30 to 56½ in. The drive is by gear and chain, giving four speeds of 2, 4, 6 and 12 miles per hour, both forward and reverse. The frame design lowers the center of gravity to a point only 36 in. above the rails, preventing pitching and rocking while the locomotive is traveling. Axles operate in roller bearings and journal boxes are dust-proof. A feature of the cab is its equipment with sliding wire-glass windows.

The gasoline motor is a 6-cylinder unit with 5¾-in. bore and 7-in. stroke, designed for heavy duty and capable of developing 115 hp. at 1,000 r.p.m. The engine is also equipped with an automatic air cleaner and has forced water circulation and forced feed lubrication. The clutch is of the multiple disk type and the transmission is of the jaw clutch and gear type, the gears being always in mesh to eliminate possibility of stripping. From the transmission drive shaft to the axles power is transmitted by chrome vanadium steel roller chains. The locomotive is equipped with a 12-volt electric lighting and starting system, consisting of generator, starter and Westinghouse storage battery.

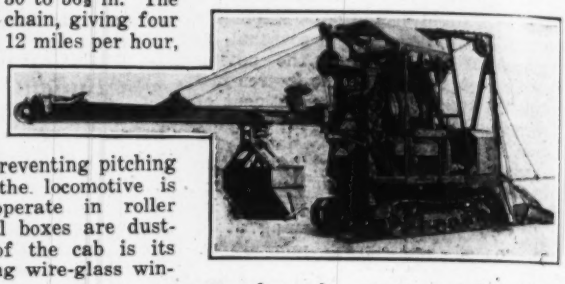


In addition to its uses on general construction work, this locomotive is designed for service around manufacturing plants, coal and lumber yards, stone quarries, gravel pits, brick and clay yards, and for switching and spotting standard-gage freight cars.

New 13-E Paving Mixer Complies with A.G.C. Standards

In line with the concrete mixer standards approved by the Associated General Contractors of America, limiting pavers to three standard sizes—7, 13, and 21 cu.ft. of mixed concrete per batch—the Koehring Co., Milwaukee, has placed on the market a new 13E paver designed to comply specifically with the requirements of a unit of this size. The new paver has been built for speed. All operations of charging and discharging are fast—from the raising of the charging skip with double cables, and automatic opening of the water valve, to the quick drum discharge and speedy placing of the concrete by the boom and bucket. The forward speed of the traction is almost 2 miles per hour.

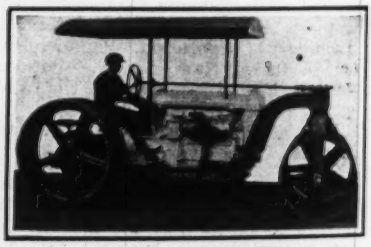
All gears, except traction, are enclosed in a self-lubricating gear case; gears have machine-cut teeth and run in a continuous oil bath. Because of this gear case frequent attention to bearings and their lubrication, which was formerly necessary, has been avoided.



The machine is built with a low head frame—its height is 140 in.—which allows city operation unhampered by bridges, wires, grade crossings, etc. The width of the mixer is 106 in., making it suitable for the construction of half-width roads, an innovation designed to aid state highway departments in keeping roads open to traffic during construction. The 13E unit can be equipped with either rubber- or steel-tired wheels or full length, self-cleaning multiplanes. A cam steering arrangement enables it to turn in its own length. These two types of traction are suitable to either city or country work. The mixer, its manufacturer points out, is small enough to be used to advantage on city jobs and is sufficiently large and adaptable for use on highway construction.

Roller Powered with Tractor Engine

An addition recently made to the line of road building equipment manufactured by the Good Roads Machinery Co., Kennett Square, Pa., consists of a light weight three-wheel road roller powered by a Fordson gasoline tractor engine and built in 4- and 5-ton sizes. The new machine, known as the Monarch Cub, has its motor mounted in a built-up channel frame of structural steel with a drive of cut steel sprockets and Diamond roller chain. The resulting traveling speeds are about one-third less than the normal speeds of the Fordson tractor.



For breaking up road surface instead of rolling, each roller wheel may be

equipped with a set of 24 steel picks. Another accessory manufactured for this type of roller is a three-tooth scarifier attached to the rear end of the channel frame and operated by a hand wheel. The teeth are spaced to break up a section of roadway 24 in. wide.

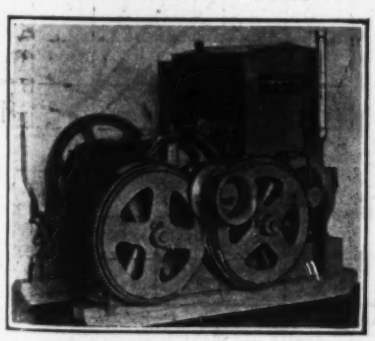
Tiny Model Rig Will Drive Piles at Road Show

Complete in all mechanical details a miniature pile-driving rig, consisting of models of a McKiernan-Terry steam hammer, a Mundy electric hoisting engine, and Lackawanna steel sheet piles, will be in operation at the Good Roads Show in Chicago, Jan. 5-9. The hoist, a single-drum machine 15 in. long, 10 in. wide and 8 in. high, is equipped with a ⅛-hp. electric motor, giving a lifting capacity of 100 lb. at a rope speed of 30 ft. per minute. The drum has a diameter of 3 in. and is wound with three layers of ⅛-in. wire rope. The hoist model is lubricated by the alemite forced feed system. The hammer, which will be operated by compressed air from a tank, is one-eighth actual size, weighs 16 lb., and is 2½ in. square and 11 in. long. The piling is in 2-ft. lengths with a web thickness of $\frac{3}{32}$ in. This working model exhibit will be at the booth of the McKiernan-Terry Drill Co., of New York.

Size of Model Hoist Indicated by Watch Leaning Against It

Single-Drum Reversible Gasoline Hoist for Building

For large-scale building operations in cities where the noise and soot of steam hoisting engines are objectionable, the C. H. & E. Manufacturing Co., Inc., Milwaukee, has recently developed a new single-drum reversible high-speed gasoline hoist equipped with a 35-hp. Waukesha engine. This machine is intended for work which is too heavy to be handled economically by the company's 15-hp. reversible gasoline hoists already on the market for operating single and double cage material elevators.

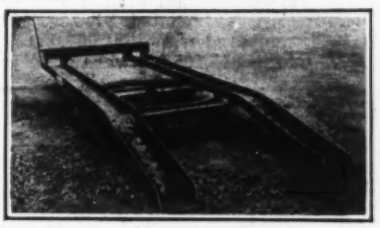


With the new hoist, illustrated herewith, a load of 2,000 lb. can be handled on the sheave wheel at a rope speed of 400 ft. per minute and a load of 4,000 lb. on the drum at 200 ft. per minute. The hoist is equipped also with a niggerhead and the engine is entirely inclosed by a sheet steel housing.

The gears are machine cut, stub tooth, and the engine has an accelerator so that it may be speeded up before lifting the load. Clutches are of the cone type, of liberal dimensions, and the sheave wheel has a diameter of 36 in. By pulling a pin the sheave wheel is allowed to run free on the main shaft, thus making the operation of the sheave wheel and the drum independent of each other.

Turntables for Road Trucks

For handling both light and heavy motor trucks on road construction work, the Blaw-Knox Co., Pittsburgh, has placed on the market new models of a 1½-ton and a 5-ton turntable. The smaller size for light trucks is of all-steel construction, with parts arranged for easy assembling in the field.

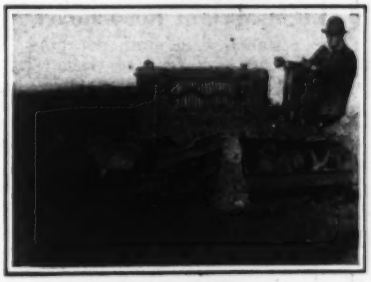


The turntable for the heavier trucks operates over the side forms and occupies a space of only about 8 ft. in width on one side of the road. It clears, in turning, forms up to 12 in. in height. The design of both types of turntable is shown in the accompanying illustrations.

Bulldozer for Tractors

A one-man tractor "bulldozer" and backfiller is a new product of the Baker Manufacturing Co., Springfield, Ill. It consists of a blade with frame built around the tractor, as shown in the accompanying photograph. The bulldozer is made for attachment to leading makes of tractors for use in pushing dirt over fills, backfilling trenches, filling in around bridges and dams as well as for spreading and leveling city dumps.

One outstanding feature of the equipment is the automatic lift which causes the blade to rise when the tractor backs up a distance of three or four feet and to lower when the tractor moves forward. The blade is carried on a frame



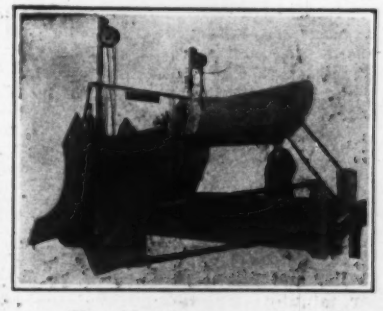
which, when the tractor is in reverse gear, moves on rollers along a track, running the blade vertically to a sufficient height to clear the dirt and prevent the pulling back of dirt when returning for the next cut.

By means of small wings on the side of the blade it is possible to carry dirt a considerable distance in cutting down short hills and placing dirt in deep fills. One man operates both tractor and bulldozer, making it a labor saver over former methods of doing this class of work. The bulldozer is readily detached by pulling two pins when the tractor is to be used for other work.

V-Shaped Snow Plow With Extensible Side Wings

Equipped with a V-shaped moldboard and a pair of extensible side wings, giving a maximum spread of 21½ ft., a new snow plow for attachment to a crawler tractor has been designed by the Wausau Iron Works, Wausau, Wis., for removing heavy falls of snow from rural highways. A feature of the equipment is the curve of the cutting edge and moldboard sides which are designed to roll the snow back instead of pushing or "bucking" it.

The device is supported by a steel framework which is hitched to the drawbar of the tractor. The plow proper is carried on combination runners and wheels, a large portion of the weight being carried by the tractor itself. The plow is adjustable as to height and can be set to clear the snow at the road surface or between this point and a height of 12 in. above the road. The moldboard is of ¼-in. steel plate and is raised or lowered by means of two hand-operated jacks of the lever

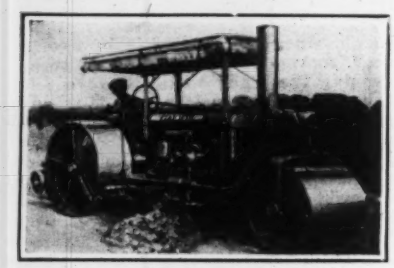


type. The side wings are adjustable as to spread and are held in place by two universal telescoping rod and steel tubes.

The snow alone weighs 6,400 lb. and its weight, with the wings, is 8,100 lb. The equipment has overall dimensions of 20 ft. in length, 15½ ft. in width, and 63 in. in height.

Light Weight Road Roller

For rolling, scarifying, scraping or planing road surfaces the Galion Iron Works & Mfg. Co., Galion, Ohio, has introduced a new light weight three-wheel roller built in sizes of 3, 4 and 5 tons. The machine is powered by a Fordson tractor engine carried by three point suspension in a full length channel frame. This unit is known as the Galion Junior and is driven through

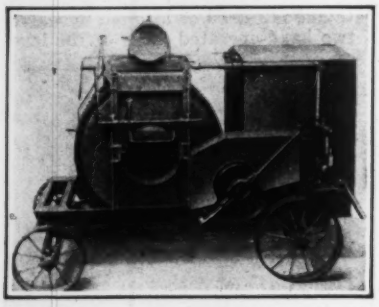


a train of steel gears permitting the use of all the speeds of the Fordson motor.

For use between the front and rear rollers there may be attached a 6-ft. or 8-ft. planer or blade adjustable for light or heavy cuts. A nine-tooth scarifier attached to the rear end of the machine, covering the full width of the roller and equipped with compression release springs, is another optional attachment. In the rear rolls there are tapered holes into which sets of plugs and spikes may be inserted for breaking up old road surfaces. The roller, the manufacturer states, is capable of pulling a 2,000-lb. road grader in addition to its other functions in construction and maintenance work.

Feed-Water Pump for Mixer

For use on bridge and general construction, where water for concrete mixing is not available from pipe lines at the site, the Marsh-Capon Co., Chicago, has equipped its 7-S mixer with a feed-water pump, shown in the accompanying illustration. This is a small rotary gear force pump with 1¼-in. suction and discharge; it weighs



85 lb., and has a capacity of 24 gal. per minute. For the convenience of contractors there has been provided a small pipe line with a cut-off valve running to the engine so that the latter may be supplied with water without the necessity of disconnecting the water line and then attaching it again. In case the contractor prefers it, the pump may be equipped merely with a hose attachment.

Business Side of Construction

FACTS AND EVENTS THAT AFFECT COST AND VOLUME

Large Projects In Prospect

The following represent just a few of the big engineering construction jobs on which bids are asked or will soon be called for. Further details are given in the Construction News section of this issue, pp. 1 to 9.

Proposed Work

Hall, terminal, hotel, etc., Chicago, Ill., for group of citizens and I. C. R.R. Co., $30,000,000.

Trunk sewer, Toronto, Ont., covering 6 sq. mi. of northern section of province, $10,000,000.

Office building, New York, N. Y., for N. Y. C. R.R., $10,000,000.

Street and road program, Wisconsin, appropriated by various counties, $5,917,684.

Extension of steel mill, Wingo Junction, O., for Carnegie Steel Co., $5,500,000.

Paving, Clayton and St. Louis Counties, Missouri, plan bond election, $5,000,000.

Furniture store, Chicago, Ill., for the American Furniture Mart Building Corp., $2,500,000.

Water-works improvements, Knoxville, Tenn., bonds voted, $2,500,000.

Hotel, Canton, O., for L. Rogers & Co., $2,000,000.

Paper mill, Ft. William, Ont., for Great Lakes Pulp and Paper Co., $1,500,000.

Schools, Knoxville, Tenn., bond election in spring, $1,500,000.

Courthouse and jail, Clayton, Mo., for St. Louis County, $1,500,000.

Apartment, New York, N. Y., for One Thousand One Hundred and Seven Fifth Avenue Corp., $1,150,000.

Dam, Lake Catonga, Que., for Quebec Running Water Comm., $1,000,000

Lodge, Des Moines, Ia., for Des Moines Consistory, $1,000,000.

Bids Wanted on Big Jobs

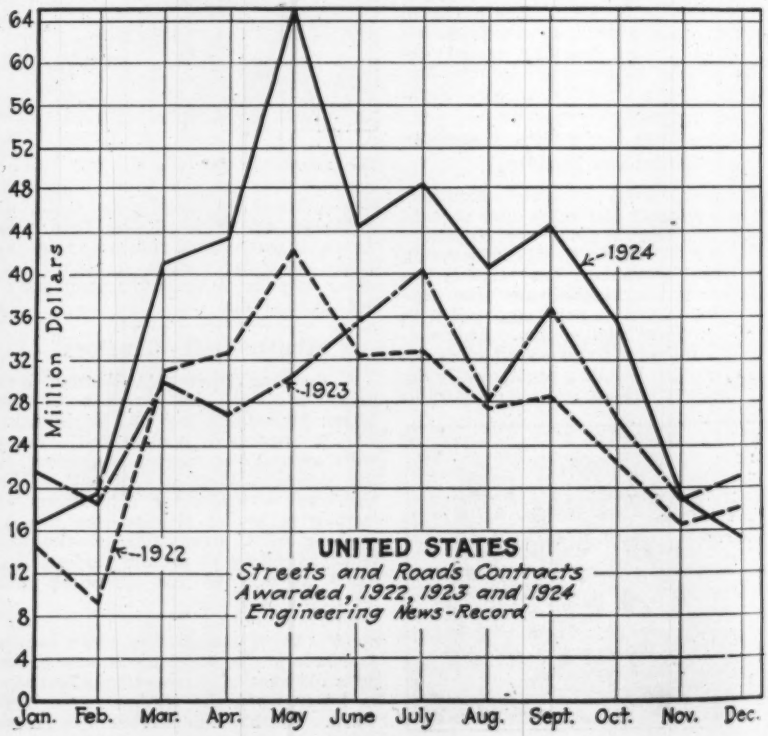
Paving, East St. Louis, Ill., W. McK. Brown, engr., $1,500,000.

Sales Rooms and offices, Cleveland, O., for Motors Realty Co., $1,500,000.

Y. M. C. A., St. Louis, Mo., B. W. Moser, $1,450,000.

Street and Road Contracts Reported in Construction News in Last Three Years

Street and road contracts of $25,000 and more, as reported to *Engineering News-Record*, aggregated $430,321,000 in 1924, compared with $381,097,000 in 1923. Of this $15,105,000 was Canadian work. Thus, according to this authority, this class of construction was 14 per cent heavier than last year. Road contracts in 1923, in turn, exceeded in value those of 1922 by 8 per cent.



Heavy Building Lettings Boost Month's Total 19 Per Cent Above November's

Rise Is in Both Industrial and Commercial Building—Principal Increases in Middle West

Heavy gains in building awards boosted the December total 19 per cent above that of the preceding month, according to *Engineering News-Record's* statistics. The gain over 1923 was 24 per cent.

The most interesting event was the heavy increase in industrial building contracts—from $18,000,000 in November to $29,000,000 in December. One of the large projects was the $5,000,000 blast furnace and power plant for the Central Steel Co. at Massillon, Ohio.

Minimum costs observed in Construction News are as follows: Water-works and excavations, $15,000; other public works, $25,000; industrial construction, $40,000; commercial buildings, $150,000.

Among the large contracts announced during the month were the following: A section of the Welland Ship Canal for $10,000,000; a $2,000,000 theatre in Detroit; a million dollar dredging job at Houston; a generating station at Cleveland to cost $10,000,000. The largest foreign contract reported was a municipal development at Bogota, S. A., to cost $3,500,000.

Engineering News-Record Construction Cost Index Number

January, 1925	**210.40**
December, 1924	208.58
January, 1924	217.90
Peak, June, 1920	273.80
1913	100.00

Jan., 1923	191.70	Jan., 1924	217.90
Feb.	197.40	Feb.	220.30
Mar.	205.25	Mar.	224.60
April	213.50	Apr.	221.60
May	216.70	May	222.38
June	220.70	June	216.85
July	222.10	July	214.40
Aug.	221.50	Aug.	213.15
Sept.	221.50	Sept.	211.25
Oct.	220.30	Oct.	207.55
Nov.	220.90	Nov.	205.70
Dec.	217.30		

Engineering News-Record's Construction Cost Index Number advanced 1.82 points since last month, owing to higher costs of steel and lumber. The average rate for common labor is now 55½c. per hr., against 56½c. one month ago and 54c. in January, 1924. Thus general construction cost is 4 per cent lower than one year ago and 23 per cent under the peak; it is 110 per cent above the 1913 level.

Engineering News-Record Construction Volume Index Number

Next week *Engineering News-Record* will describe its new method of calculating construction volume and will present a twelve-year tabulation of the new number, which will take the place of the one used heretofore. See table-of-contents talk.

December, 1924 (*4 issues of E. N.-R.*)	**128**
November, 1924 (*4 issues of E. N.-R.*)	108
December, 1923 (*4 issues of E. N.-R.*)	101

Engineering News-Record's Construction Volume Index Number is 128 for the month of December, and 135 for the whole of 1923, as against 100 for 1913. This means that the actual volume of construction in 1923 (not the mere money-value of the contracts let that year) is 35 per cent above the volume of construction for 1913. Our monthly volume number, 128 for December, 1924, contains the increment of construction and indicates the rate at which contracts are being let as compared with 1913 awards.

VALUE OF CONTRACTS LET IN THE UNITED STATES AND CANADA DURING DECEMBER, 1924

	New England	Middle Atlantic	South	Middle West	West of Mississippi	Far West	United States	Canada	Grand Total
Water-works	$350,000	$334,000	$294,000	$1,576,000	$495,000	$73,000	$3,122,000	$18,000	$3,140,000
Sewers	53,000	5,505,000	354,000	790,000	837,000	222,000	7,761,000	174,000	7,935,000
Bridges	98,000	249,000	242,000	570,000	912,000	411,000	2,482,000	159,000	2,641,000
Excavation, drainage and irrigation	61,000	.....	700,000	.....	1,045,000	167,000	1,973,000	10,000,000	11,973,000
Streets and roads	1,103,000	717,000	1,083,000	1,955,000	7,944,000	1,954,000	14,756,000	138,000	14,894,000
Industrial buildings	3,261,000	1,642,000	775,000	18,886,000	1,768,000	1,115,000	27,447,000	2,087,000	29,534,000
Commercial buildings	9,451,000	25,478,000	1,698,000	12,215,000	7,289,000	13,972,000	70,103,000	1,146,000	71,249,000
Federal Government	164,000	655,000	289,000	71,000	95,000	1,032,000	2,306,000	.....	2,306,000
Unclassified	1,120,000	3,687,000	865,000	1,618,000	2,264,000	1,512,000	11,066,000	25,000	11,091,000
December, 1924	$15,661,000	$38,267,000	$6,300,000	$37,681,000	$22,649,000	$20,458,000	$141,016,000	$13,747,000	$154,763,000
November, 1924	$10,801,000	$36,015,000	$11,991,000	$23,937,000	$27,595,000	$13,655,000	$123,994,000	$6,163,000	$130,157,000
Entire year 1924	151,556,000	604,576,000	208,071,000	431,039,000	340,622,000	266,669,000	2,002,533,000	102,923,000	2,105,456,000

Labor Rates and Conditions Throughout the Country

If the recent heavy volume of transactions in the stock market may be taken as a sign of confidence in the immediate future of business, so may the same indicator be pointing to the danger of price inflation.

The latest findings of the National Industrial Conference Board are to the effect that the cost of living has risen only slightly (2.2 per cent) since midsummer.

At the same time the Bureau of Labor Statistics informs us that the hourly union wage rate on May 15, 1924, was higher than in any preceding year. The accompanying table shows the May, 1924 wage gain compared with other years:

Per Cent Rise	Above the month of May in the following years
8.3	1923
99.8	1917
128.1	1913
141.5	1910
154.2	1907

Part time schedules throughout 1924 have greatly reduced average weekly earnings. This condition, however, is giving way to a steady increase in the number of hours of work per week.

The U. S. Department of Labor finds that plasterers' wages, for instance, are now 117 per cent above the 1913 level. The carpenters' rate is 110 per cent higher; the bricklayers', 103 per cent; and that of unskilled laborers, 134 per cent above 1913. Plasterers' wages advanced 13 per cent; bricklayers', 8.5 per cent; carpenters', 7 per cent; and common laborers', only 1 per cent during 1924.

Local conditions as reported to *Engineering News-Record*, follow:

Atlanta — Present building trades wage schedule will hold for 1925.

Baltimore—Starting off the new year with everything normal in the building industry. Present wage scale will continue in effect.

Birmingham—Advance of 10c. per hr. granted carpenters. Common labor situation a trifle easier owing to emigration of men from colder localities.

Dallas—There is a surplus of building laborers at the present time in Dallas. Common laborers may be had for 30 to 50c. per hr., against 40 to 75c., one month ago. Wage scale for skilled men will remain the same as during 1924, inasmuch as about 40 per cent of all construction work is done on the open shop basis.

Detroit—No definite indications exist that building trades mechanics will demand higher rates for next season.

Los Angeles—Market over-run with certain trades owing to winter influx of migratory labor. Great variation in skilled mechanics' wages.

Minneapolis—No prospect that building trades mechanics will demand higher rates for next season. No wage disputes and no unsettled strikes.

CURRENT BUILDING TRADES WAGE RATES PER HOUR
(Higher rates indicated by +, decreases by —)

Cities	Bricklayers	Carpenters	Hoisting Engineers	Hod Carriers	Pile Drivers	Structural Iron Workers	Common Labor
Atlanta	$1.12½	$0.70	$0.70	$0.50	.....	$0.75	$0.25@.30
Baltimore	1.75	.90@1.20	1.00@1.12½	1.00	$0.65	1.12½	.40
Birmingham	1.00@1.50	+.35@.75	.75@1.25	.35@.50	.....	.75@1.25	.21@.40
Boston	1.25	1.00@1.10	1.25@1.35	.87½	1.05	1.25	.50@.57
Cincinnati	1.50	1.25	1.25	.92½	1.25	1.25	.55
Chicago	1.50	1.15@1.25	1.10@1.25	1.00	1.25	1.25	.75@.82½
Cleveland	1.50	1.25	+1.30	.87½	1.00	1.37½	.87½
Dallas	1.50	1.00	1.00	.40@.75	.87½	1.00	—30@.50
Denver	1.62½	1.12½	1.12½@1.18¾	.81¼@.87½	1.00	1.15¾	.35@.55
Detroit	1.50	.90@1.00	.85@1.00	.90	.85@1.00	1.12½	.60@.75
Kansas City	1.50	1.00@1.25	1.00@1.25	.87½	1.00@1.12½	1.00@1.12½	.50@.75
Los Angeles	—1.00@1.25	+.90@.100	—.75	—.90@1.12	+.87½	.87½	.50
Minneapolis	1.12½	.87½	.87½	.71½	.....	.87½	.50@.55
Montreal	1.00	.65	.62½	.45	.50	.65	.25@.30
New Orleans	1.25	.90	1.00	.65	.80	+1.12½	.35@.40
New York	1.50	1.31¼	1.50	1.00	1.00@1.12½	1.31¼	.62½@.75
Philadelphia	1.50	1.12½	1.02½	1.12½	1.00	1.12½	.40@.45
Pittsburgh	1.55	1.37½	1.25@1.37½	1.00	.....	1.37½	.70
St. Louis	1.75	1.50	1.50@1.67½	1.15@1.25	+1.50	1.50	.77½
San Francisco	1.25	1.00	1.00	.81¼	1.00	1.12½	.50@.55
Seattle	1.25	1.00	1.00@1.12½	1.00	1.00@1.12½	1.12½	—.50@.62½

New Orleans—Structural iron workers granted advance of 12½c. per hr. over old schedule. Wages of other trades will remain the same as in 1924.

New York—Building has been slowing down gradually in this city since mid-summer. Since Dec. 1 however, increasing construction cost has brought more prospective builders into the market. The present wage schedule will prevail until Dec. 31, 1925.

Philadelphia—There are no unsettled strikes or wage disputes pending. It is not expected that building trades mechanics will demand higher rates during 1925.

Pittsburgh — Building craftsmen plentiful. No anticipated changes in wage schedules.

St. Louis—Pile drivers granted increase of 25c. per hr. over old scale; 1924 rates hold on other trades.

San Francisco—No change in wage line-up.

Seattle—Some unemployment still exists but condition does not affect skilled trades. Common laborers paid a minimum of 50c. per hr., against 62½c., formerly.

Monthly Prices of Construction Materials

Ups and Downs of the Market

The upward trend in materials' prices continues. Advances are noticeable in pig iron, scrap, railroad spikes, light rails, steel bars, structurals, concrete aggregates, paving materials and paint stuffs. Cast-iron pipe demand is better, but prices have not yet started to rise. Though declines predominate in the lumber market, increasing firmness is developing in the northern sections of the country.

Pig Iron—Recent wage advances in the Connellsville coke region have added at least $1 per ton to the cost of pig-iron production. Price of delivered iron is about $1 per ton above a month ago.

Railway Supplies—Active demand for rails and other equipment. Principal advance in track supplies is rise of $2 per ton in standard spikes. This is the second advance of the kind in two months.

Pipe—There is considerable demand for cast-iron pipe in the current market. Price firmness, however, has not yet developed. The slight decline in sewer pipe and clay drain tile is seasonal. Wrought-steel pipe firm at present levels.

Road and Paving Materials—Unseasonal advances, developing in these materials, are as follows: Slight rise in road oils in the South; higher asphalt prices in Philadelphia, Los Angeles and Birmingham; increased cost of granite blocks in New York and wood blocks in New Orleans, during the month.

Sand, Gravel and Crushed Stone—Gravel is up 25c. per cu.yd. in the New York district, compared with a month ago. A slightly easier situation prevails in the South. Sand advanced 25c. in New York, 50c. per cu.yd. in New Orleans and 15c. per ton in Birmingham since December 1. Low temperatures will cause further firmness, particularly in the North. Of all the concrete aggregates, crushed stone shows the least tendency to fluctuate. A rising tendency, however, is reported in the South.

Lime and Cement—The lime situation is one where advances balance the declines. Cement remains stable as it has for the past year or more in the Eastern states; reductions averaging 10c. per bbl. are reported in various parts of the West.

Brick and Hollow Tile—The present trend of clay products' prices is downward. This will probably result in a strong upward turn in less than sixty days, at which time active buying for spring construction will begin.

Structural Steel—Nothing much is being quoted under $2.10 per 100 lb. at Pittsburgh for either bars or shapes; plates are about $2. This is equivalent to a rise of 25c. per 100 lb. in one month. The advancing tendency of steel is due more to fear of continued upward trend in prices than to possibilities of scarcity at the mills or warehouses.

Lumber—Demand, particularly for yellow pine, shows an improvement not usually present at this time of the year. About the only slow moving material on the market now is plaster lath. While price declines predominate, there is increasing firmness in pine, fir and hemlock in many sections of the northern half of the country.

Linseed Oil—Raw oil is now $1.17 per gal. in 5 bbl. lots f.o.b. New York, against $1.11 one month ago. The rise is characteristic of the entire country.

Iron and Steel Scrap—Average rise of about $2 per ton since December, due to incerasing demand and higher iron and steel prices.

Red and White Lead—Rise of ½c. per lb. occurred during the month, owing to higher prices of non-ferrous metals.

Prices advance since last month are indicated by **heavy type**; declines by *italics*

PIG IRON—Per Gross Ton f.o.b.:

	Jan. 1	One Year Ago
CINCINNATI		
No. 2 Southern (silicon 2.25@2.75)	**$24.05**	$25.05
Northern Basic	**22.77**	24.00
Southern Ohio No. 2 (silicon 1.75@2.25)	**22.77**	24.00
NEW YORK, tidewater delivery		
Southern No. 2 (silicon 2.25@2.75)	**30.25**	28.00
BIRMINGHAM		
No. 2 Foundry (silicon 2.25@2.75)	**20.00**	22.00
PHILADELPHIA		
Eastern Pa., No. 2X (2.25@2.75 sil.)	**24.26**	24.25
Virginia No. 2 (silicon 2.25@2.75)	**30.17**	28.17
Basic	**23.26**	24.00
Gray Forge	**22.75**	24.00
CHICAGO		
No. 2 Foundry Local (silicon 1.75@2.25)	**22.00**	24.50
No. 2 Foundry Southern (silicon 2.25@2.75)	**25.55**	27.00
PITTSBURGH, including freight charge from the Valley		
No. 2 Foundry Valley (silicon 1.75@2.25)	**23.77**	25.77
Basic	**23.77**	25.77
Bessemer	23.77	26.77

SCRAP—The prices following are f.o.b., per gross ton paid to dealers and producers:

	New York	Chicago	Birmingham
No. 1 railroad wrought	**$16.00**	$16.50@17	$13@14
Stove plate	**13.00**	16@16.50	14@15
No. 1 machinery cast	**16.00**	19@19.50	16@17
Machine shop turnings	**11.00**	12@12.50	7@8
Cast borings	**11.00**	14.25@14.75	15@16
Railroad malleable	**15.00**	20@20.50	18@19
Re-rolling rails	**16.00**	20@20.50	17.00
Re-laying rails	22.00	26@32	26.00
Heavy melting steel	**15.00**	17.50@18	18@19

*Per net ton.

Railway Supplies

STEEL RAILS—The following quotations are per ton f.o.b. for carload or larger lots. For less than carload lots 5c. per 100 lb. is charged extra:

	Pittsburgh Jan. 1	Pittsburgh One Year Ago	Birmingham	Chicago	St. Louis
Standard bessemer rails	$43.00	$43.00	$43.00	$43.00	$46@49
Standard openhearth rails	43.00	43.00	43.00	43.00	*48@52*
Light rails, 8 to 10 lb	36@**38**	45.00	2.00*	36@38	
Light rails, 12 to 14 lb	36@**38**	45.00	2.00*	36@38	2.05@2.15
Light rails, 25 to 45 lb	36@**38**	45.00	2.00*	36@38	1.95@2.10
Re-rolled rails	*27@30*	37@40			

*Per 100 lb.

RAILWAY TIES—For fair-sized orders, the following prices per tie hold:

	6 In. x 8 In. by 8½ Ft.	7 In. x 9 In. by 8½ Ft.
Chicago, White Oak	**$1.60**	**$2.00**
Chicago, (creosoted) (zinc treated)	*1.70*	2.10
San Francisco, Green Douglas Fir	.84	1.14
San Francisco, Empty Cell Creosoted, Douglas Fir	1.70	2.25
St. Louis, White Oak, plain	1.20	1.40
St. Louis (creosoted) (zinc treated)	1.60	1.90
St. Louis, Red Oak, plain	1.10	1.30
St. Louis, Sap pine-cypress	.95	1.15
St. Louis, yellow pine	1.00	1.30
Birmingham, White Oak	1.25	*1.45*

TRACK SUPPLIES—The following prices are base per 100 lb. f.o.b. Pittsburgh for carload lots, together with the warehouse prices at the places named

	Pittsburgh Jan. 1	Pittsburgh One Year Ago	Chicago	St. Louis	San Francisco	Birmingham
Standard spikes, ⅝-in. and larger	**$2.90**	$3.00@3.15	**$3.45**	*$3.55*	$4.35	**$2.80**
Track bolts	3.75@4.00	4.00@4.25	**4.45**	**4.55**@4.90	5.85	4.00
Standard section angle bars	2.75	2.75	**3.30**	3.40	4.00	2.85

*Mill.

Pipe

WROUGHT PIPE—The following discounts are to jobbers for carload lots at Pittsburgh mill:

Inches	Steel Black	Steel Galv.	Inches	Iron Black	Iron Galv.
		BUTT WELD			
1 to 3	62	50½	1 to 1½	30	13
		LAP WELD			
2	55	43½	2	23	7
2½ to 6	59	47½	2½	26	11
7 and 8	56	43½	3 to 6	28	13
9 and 10	54	41½	7 to 12	26	11
11 and 12	53	40½			

	BUTT WELD, EXTRA STRONG, PLAIN ENDS				
1 to 1½	60	49½	1 to 1½	30	14
2 to 3	61	50½			
	LAP WELD, EXTRA STRONG, PLAIN ENDS				
2	53	42½	2	23	9
2½ to 4	57	46½	2½ to 4	29	15
4½ to 6	56	45½	4½ to 6	28	14
7 and 8	52	39½	7 and 8	21	7
9 and 10	45	32½	9 to 12	16	2
11 and 12	44	31½			

WROUGHT PIPE—From warehouses at the places named the following discounts hold for steel pipe:

	Black New York	Black Chicago	Black Birmingham	Black St. Louis
1 to 3 in. butt welded	48%	59½%	62%	49%
2½ to 6 in. lap welded	44%	56½%	59%	46%
	Galvanized New York	Galvanized Chicago	Galvanized Birmingham	Galvanized St. Louis
1 to 3 in. butt welded	34%	48%	50½%	36%
2½ to 6 in. lap welded	30%	45%	47%	33%

Malleable fittings, Classes B and C, banded, from New York stock sell at list plus 4%; class A, plus 23%. Cast iron, standard sizes, 36% off.

CAST-IRON PIPE—The following are prices per net ton for carload lots:

	Birmingham	Pittsburgh	New York Dec. 4	New York One Year Ago
4 in.	$44.00	*$56.50@57.50*	$60.60@61.66	$67.10@68.60
6 in. and over	40.00	*52.50@53.50*	55.60@56.60	62.10@63.60
		Chicago	St. Louis	San Francisco
4 in.		$51.20@52.20	$52.60	*$57.00*
6 in. and over		47.20@48.20	48.60	*53.00*

Gas pipe and Class "A," $4 per ton extra.

CLAY DRAIN TILE—The following prices are per 1,000 lin.ft.:

Size, In.	New York Jan. 1	New York One Year Ago	St. Louis	Birmingham	San Francisco	Dallas
3	**$48.00**	$45.00	$40.00	$45.00		$73.00
4	*50.00*	55.00	40.00	56.00	$76.50	110.00
5	*70.00*	80.00		80.00	97.75	118.00
6	92.00	105.00	70.00	104.00	127.50	150.00
8	*160.00*	170.00	170.00	170.00	212.50	210.00

SEWER PIPE—The following prices are in cents per foot for standard pipe in car load lots, f.o.b., except as otherwise stated:

Size, In.	New York Delivered	Pittsburgh	Birmingham	St. Louis	Chicago	San Francisco	Dallas
3		$0.09	$0.10			$0.12	
4		.09	.10	$0.10		.15	$0.15
5		.135	.149			.18	.18
6	$0.21	.135	.149	.14		.21	.21
8	*.35*	.21	.232	.225		.30	.325
10	*.52*	.315	.347	.315		.42	.476
12	*.67*	.405	*.45*	.405†		.54	.612
15	1.14†	.54	**.67**	.675†		.90	1.02
18	1.65†	.75	**.85**	*.945*†		1.32	1.53
20	*1.98*†	.90	*.99*	1.26†			1.564
22	2.65†	1.20	*1.40*				1.564
24	2.97†	1.35	*1.50*	1.62†		2.16	2.04
27	4.65†	2.665	*2.70*	2.45†		3.00	3.34
30	5.16†	2.952	3.00	3.00†		3.60	4.06
33	6.98†	3.96	4.00	3.55†			4.99
36	8.00†	4.51	*4.55*	3.95†			5.42
		3	5	8	12	24	36
Boston		$0.13	*$0.21*	*$0.35*	*$0.70*	*$2.25*†	*$6.50*†
Minneapolis				.40	.72	2.55†	5.66†
Denver		.135*	.18*	.27	.47	1.70	
Seattle		.14		.35	.72†	2.60†	
Los Angeles		.1625	.195	.275	.495	1.65	
New Orleans		*.118**	*.177**	*.295*	*.501*	**1.121**	
Cincinnati		.105	.1575	.245	.4725	1.575	4.715
Atlanta		*.10**	**.15***	**.25**	**.425**	**1.625**	
Montreal		.68‡	.45†	.70	1.35	4.50†	
Detroit		0.93	.1395	.217	.4185	2.115†	5.535†
Baltimore		.111	.166	.259	.499	1.665	4.92
Kansas City, Mo.		.15*	.21*	.335	.52†	2.09†	4.00†
Philadelphia		.12	.18	.28	.54	1.80	4.61

*4-in., 6-in., 9-in., respectively. †Double Strength. ‡3-in. special.

Road and Paving Materials

ROAD OILS—Following are prices per gallon in tank cars 8,000 gal. minimum f.o.b. place named:

		Jan. 1	One Year Ago
New York, 45% asphalt	(at terminal)	$0.07	$0.053
New York, 65% asphalt	(at terminal)	.0725	.052
New York, binder	(at terminal)	.075	.06
New York, flux	(at terminal)	.075	.06
New York, liquid asphalt	(at terminal)	.075	.048
St. Louis, 40@50% asphalt		.0475	.053
St. Louis, 50@60% asphalt		.0481	.055
Birmingham, 45% asphalt		.0495	
Birmingham, 55% asphalt		**.0465**	
Dallas, 45% asphalt		.0495	.0495
Dallas, 55% asphalt		.0455	.0455
Dallas, binder		.061	.061
San Francisco, binder, per ton		11.00*	9.50*

* F.o.b. Oelum, Cal. Freight to San Francisco, 80c. per ton.

ASPHALT—Price per ton in packages (350-lb. bbls. or 425-lb. drums) and in bulk in carload lots, f.o.b. points listed:

	Package	Bulk
New York (*Mexican*)	$23.00*	$18.00
Boston (*Mexican*)	21.00	*16.00*
Chicago (*Stanolind*)	21.00	15.00
San Francisco, *f.o.b. refinery*, Oleum, Cal.	17.00	11.00
Dallas (*Texas*)	27.10	21.10
Seattle, *"D" grade, California, f.o.b. Richmond*	22.25	20.50
Denver (*California*)	24.00	....
Minneapolis, *f.o.b. Twin Cities* (*Stanolind*)	25.10	19.10
St. Louis (*Mexican*)	28.50	23.50
Baltimore (*Mexican*)	18.00	14.00
Montreal (*Imperial*)	28.00	21.00
Atlanta (*Mexican*)	32.00	28.50
Detroit (*Mexican*)	22.00	18.00
Cincinnati (*Kentucky Rock*)	....	11.65
Maurer, N. J. (*Bermudez*)	28.00	26.00
Maurer, N. J. (*Mexican*)	20.50	17.50
Philadelphia (*Mexican*)	20.00	16.00
Kansas City (*Texas*)	27.30	25.30
Los Angeles (*"D" grade, California*)	18@19.10	12.00†
Birmingham (*Mexican*)	32.00	29.00
New Orleans (*Mexican*)	23.00	17.00

*In drums. †f.o.b. El Segundo Refinery.

NOTE—Barrels or drums are optional in most cities. About 6 bbls. to the ton, and from 4 to 5 drums; 200 to 300 gal. to the ton.

PAVING STONE—

New York (grade 1)	5-in. granite, 30 blocks per sq.yd.	$135.00@142.00 per M.
Chicago	About 4x8x4 dressed	per sq.yd.
	About 4x8x4 common	per sq.yd.
San Francisco	Basalt block 4x7x8	70.00 per M.
Boston	5-in. granite, 28 blocks per sq.yd.	*132.00* per M.
Atlanta	Granite	2.50 per sq.yd.
Detroit	5-in. Granite	3.00 per sq.yd.
Baltimore	Granite	2.85 per sq.yd.
Montreal	Granite	104.75 per M.
New Orleans	Granite, 4x8x4	3.25 per sq.yd.
Cincinnati	Granite	135.00 per M.
St. Louis	4x8x4	1.65 per sq.yd.
Kansas City	Granite	4.00 per sq.yd.
Philadelphia	Granite	3.25@4.25 per sq.yd.
Minneapolis	Sandstone	2.74 per sq.yd.

FLAGGING—

New York	Bronx, 4 ft. wide	$0.22 per sq.ft.
	Manhattan, 4 ft. wide	.22 per sq.ft.
	Queens, 5 ft. wide	.24 per sq.ft.
	6x24-in. cross-walk	1.20 per lin.ft.
Chicago	18 in. wide	.... per lin.ft.

CURBING—*New York:* Bluestone per lin.ft., f.o.b. barge New York, 5x16 in., 85c.; 5x20 in., Queens, 90c. *St. Louis:* Class "A" straight, delivered, 5x16 in., 90c. per lin.ft.

WOOD BLOCK PAVING—

	Size of Block	Treatment	Per Sq.Yd
New York (*delivered*)	3	16	$2.39
New York (*delivered*)	3½	16	2.67
Boston	3½	18	2.60
Chicago	4	16	....
Chicago	3½	16	....
St. Louis	3½	16	2.40
St. Louis	4	16	2.70
Seattle	4	16	Off market
Minneapolis	3½	16	2.75
Atlanta	3½	16	2.00
New Orleans	3	16	2.20
New Orleans	3½	16	2.30
New Orleans	4	16	2.40
Dallas	4	18	3.90
Baltimore	3½	16	None used
Montreal	4	16	4.50
Detroit	3	16	1.94
Detroit	4	16	....
Cincinnati	3½	16	2.38
Kansas City	4	16	3.95
Philadelphia	4	16	None used

Construction Materials

SAND AND GRAVEL—Price for cargo or carload lots to contractor is as follows, per cu.yd.:

	Gravel 1½ In. Jan. 1	Gravel 1½ In. One Year Ago	Gravel ¾ In. Jan. 1	Gravel ¾ In. One Year Ago	Sand Jan. 1	Sand One Year Ago
New York (*alongside dock*)	$2.25	$2.00	$2.25	$2.00	$1.25	$1.25
Denver	1.90	1.90	1.90	1.90	1.00	1.00
Chicago	3.00	2.00	3.00	2.00	3.00	2.00
St. Louis	1.45†	1.40†	1.45†	1.45†	1.18†	1.20†
Seattle	1.50	1.25	1.50	1.25	1.50	1.25
Dallas	2.38	2.38	2.38	2.38	2.00	2.00
Minneapolis	1.65*	1.85*	1.65*	1.85*	1.25	1.25
Cincinnati	1.40†	1.35	1.40†	1.35	1.35†	1.30
San Francisco	2.15	2.15	2.15	2.15	1.50	1.50
Boston	1.50†	1.40†	1.50†	1.40†	1.00†	1.10†
New Orleans	*2.63*	2.85	*2.63*	2.85	1.75	1.25
Los Angeles	1.50*	2.50	1.55†	2.50	1.10†	1.75
Atlanta	1.90†	1.75†	1.90†	1.75†	1.40†	1.20†
Detroit	2.02	1.62	2.02	1.62	1.62	2.02‡
Baltimore	1.40	1.40	1.60	1.60	0.70†	0.70†
Montreal	1.25†	1.25†	1.25†	1.50†	1.25†	1.25†
Birmingham	2.00	....	2.00	....	1.45†	1.30†
Philadelphia	2.10	2.15	2.10	2.15	1.50	1.65†
Kansas City	4.00‡	....	4.00‡	....	0.66*	0.66*†

New York—Grits, $2.25 per cu. yd.; ready mixed, $2.00.
Los Angeles—Freight from quarry, 70c. per ton, and is included in above price.
* At pit. † Per ton.

CRUSHED STONE—Price for cargo or carload lots f.o.b. city, unless stated otherwise, is as follows, per cu.yd.:

	1½ In. Jan. 1	1½ In. One Year Ago	¾ In. Jan. 1	¾ In. One Year Ago
New York	$1.75	$1.65	$1.85	$1.75
Chicago	3.00	2.00	3.00	2.00
St. Louis	1.75*	2.25*	1.75*	2.25*
Dallas	2.40	2.83	2.83	2.83
San Francisco	2.15	2.15	2.15	2.15
Boston	1.60*	1.55*	1.60*	1.55*
Minneapolis	1.75	1.85	1.75	2.00
Kansas City	1.50	1.50	1.50	1.50
Denver	*2.50*	3.50	*2.50*	3.50
Seattle	3.00	3.00	3.00	3.00
Atlanta	2.00*	1.90*	2.00*	1.90*
Cincinnati	1.90*	1.65	1.90*	1.65
Los Angeles	1.65*	....	1.75*	....
Detroit	1.70	1.75	1.70	1.75
Baltimore	2.50	2.50	2.55	2.55
Montreal	1.80*	1.80*	2.25*	1.90*
Philadelphia	2.10	2.15*	2.10	2.15*
Pittsburgh	2.85	2.85	2.85	2.85
Cleveland	3.25*	3.25*	3.25*	3.25*
Birmingham	2.00	....	2.00	....

*Per ton.

CRUSHED SLAG—Price of crushed slag in carload lots, per net ton, at plants:

	1½-In.	¾-In.	Roofing	Sand
Youngstown District	$1.25	$1.35	$2.00	$1.25
Steubenville District	1.25	1.30	2.00	1.30
Ironton District	1.40	1.40	2.00	1.40
Easton, Catasauqua, Pa.	....	....	2.50	....
Birmingham, Ala.	1.00	1.20	....	....
Buffalo, N. Y., and Erie, Pa.	1.25	1.25	2.25	1.25
Cleveland, Ohio	1.30	*1.50*	1.30	1.30
Eastern Pa. and Northern N. J.	1.25	1.25	2.50	1.25
Western Pennsylvania	1.25	1.25	2.50	1.25
Longdale and Glen Wilton, Va.	1.25	1.25	2.50	....
Toledo, Ohio	1.25	1.25	1.50	1.25

LIME—Warehouse prices:

	Hydrated, per Ton— Finishing	Hydrated, per Ton— Common	Lump, per Barrel— Finishing	Lump, per Barrel— Common
New York	$18.20	$12.00@$13.10	$3.75*	$2.50@3.00*
Chicago	20.00	....	....	1.50†
St. Louis	24.00	20.00	....	18.75‡
Boston	20.00	15.00	3.90*	3.15*
Dallas	20.00	....	....	1.85†
Cincinnati	16.80	14.30	....	13.40‡
San Francisco	22.00	....	....	1.60†
Minneapolis	23.00	21.00 (white)	1.60†	1.35†
Denver	24.00	....	....	2.70†
Detroit	*16.00*	....	....	17.00‡
Seattle, *paper sacks*	24.00	....	2.80†	....
Los Angeles	....	....	18.00‡	2.70†
Baltimore	24.25	17.85	2.55†	....
Montreal	....	21.00	....	10.50‡
Atlanta	22.50	14.00	2.10†	1.45†
New Orleans	24.00	*17.00*	*2.00*†	*2.00*†
Philadelphia	23.00	16.00	....	....
Kansas City	19.50	....	17.50‡	15.00‡
Birmingham	20.00	15.00	2.10†	1.75†

*Per 280-lb. bbl. (net). †Per 180-lb. bbl. (net). ‡Per ton—Refund of 10c. per bbl. Minneapolis quotes brown common lump lime; Kelly Is. white is $1.80, Sheboygan $1.70. New York quotes hydrated lime "on cars" in paper sacks, lump lime "alongside dealer's dock" or "on cars."

NATURAL CEMENT—Price to dealers per bbl. for 500 bbl. or over, f.o.b. exclusive of bags:

	Jan. 1	One Year Ago
Minneapolis (Rosendale)	$2.80	$2.80
Kansas City (Ft. Scott)	1.50	1.50
Cincinnati (Utica)	1.72	1.72
Boston (Rosendale)	2.50	2.80
St. Louis (Carney)	2.35	2.25
Birmingham (Magnolia) pozzolan cement	2.25	2.10

PORTLAND CEMENT—Prices to contractors per bbl. in carload lots f.o.b. points listed *without bags*. Cash discount not deducted.

	Jan. 1	One Month Ago	One Year Ago
New York, del. by truck	$2.50@2.60	$2.50@2.60	$2.50@2.60
New York, alongside dock to dealers	2.15	2.15	2.15
Jersey City	2.33	2.33	2.33
Boston	1.67½	2.67½	2.63
Chicago	*2.10*	2.20	2.10
Pittsburgh	2.19	2.19	2.19
Cleveland	2.39	2.39	2.41
Detroit	2.40	2.40	2.37
Indianapolis	*2.31*	2.41	2.31
Milwaukee	*2.35*	2.35	2.25
Duluth	2.19	2.19	2.19
Peoria	*2.27*	2.37	2.27
Cedar Rapids	*2.38*	2.44	2.38
Davenport	*2.29*	2.39	2.29
St. Louis	*2.20*	2.30	2.20
San Francisco	2.61	2.61	2.61
New Orleans	2.40	2.80	2.40
Minneapolis	2.42	2.42	2.42
Denver	2.84	2.84	2.90
Seattle	2.65	2.65	2.90
Dallas	2.05	2.05	2.05
Atlanta	2.35	2.35	2.35
Cincinnati	*2.37*	2.47	2.41
Los Angeles	2.60	2.60	3.16
Baltimore	2.90	2.90	2.50
Birmingham	2.40	2.40	2.80
Kansas City	*2.07*	2.07	2.27
Montreal	1.80	1.80	2.25
Philadelphia	2.41	2.41	2.41
St. Paul	2.42	2.42	2.42
Toledo	*2.36*	2.45	2.38

NOTE—Bags 10c. each, 40c. per bbl.; 20c. each in Canada, 80c. per bbl.

Current mill-prices per barrel in carload lots, without bags, to contractors:

Buffington, Ind	*$1.85*	Hudson, N. Y.	$2.05
Universal, Pa.	1.95	Leeds, Ala.	1.95
Steelton, Minn.	2.00	Hannibal, Mo.	2.05
Fordwick, Va.	2.05	Lehigh Valley District	1.95
Mitchell, Ind.	2.05	Wyandotte, Mich.	2.15
Iola, Kan.	1.95	Alpena, Mich.	2.00
Mason City, Ia.	2.00	Richard City, Tenn.	2.05
La Salle, Ill.	2.05	Kingsport, Tenn.	2.05

TRIANGLE MESH—Price per 100 sq.ft. in carload lots:

PLAIN 4-INCH BY 4-INCH MESH

Style Number	Weight in Pounds per 100 sq.ft.	Pittsburgh Mill	Birmingham Mill	Warehouse: New York	St. Louis	Dallas	San Francisco
022	22	**$0.97**	$0.95	$1.39	$1.04	$1.13	**$1.22**
028	28	**1.23**	1.20	1.76	1.32	1.38	**1.52**
035	35	**1.51**	1.47	2.16	1.62	1.67	**1.87**
045	45	**1.94**	1.90	2.77	2.08	2.00	**2.40**
057	57	**2.39**	2.35	3.45	2.57	2.55	**2.97**
068	68	**2.86**	2.80	4.11	3.07	3.15	.....
078	78	**3.28**	3.25	5.70	3.52	3.47	.....
103	103	**4.33**	4.25	6.21	4.65	4.58	.....
119	119	**5.00**	4.90	7.19	5.38	5.26	**6.23**
138	138	**5.80**	5.70	8.35	6.23	6.11	.....
160	160	**6.72**	6.60	9.65	7.22	7.12	.....

PAVING

036P	17	**$0.74**	$0.72	$1.06	$0.80	$0.76	.....
053P	24	**1.04**	1.02	1.50	1.12	1.07	.....
072P	31	**1.32**	1.29	1.90	1.42	1.39	.....
097P	40	**1.70**	....	2.45	1.83	1.90	.....
049R	24	**1.04**	1.66	....	1.12	1.07	.....
067R	31	**1.32**	....	....	1.42	1.39	.....
089R	40	**1.70**	....	....	1.83	1.90	.....

In rolls, 48-, 52-, and 56-in. wide and in 150-, 200- and 300-ft. lengths. Galvanized is about 15% higher. Size of roll carried in New York warehouses, 48 in. wide x 150 ft. long, or 600 sq.ft.

EXPANDED METAL LATH—Prices in carload lots per 100 yd. for painted are as follows:

Weight in pounds	New York	Birmingham	St. Louis	San Francisco	Dallas
2.2	$21.00	**$22.00**	$19.00	$24.00	$23.50
2.5	23.00	**23.00**	21.00	26.00	25.00
3.0	27.00	**26.00**	24.50	30.00	28.50
3.4	29.00	**28.00**	26.50	.....	31.00

BARS, CONCRETE REINFORCING—Current quotations per 100 lb.:

ROLLED FROM BILLETS

Inches	Pittsburgh Mill	Birmingham	Warehouse, Uncut: New York	Chicago	St. Louis	Dallas	San Francisco
½ and larger	$2.10	**$2.25**	$3.24	$3.00	$3.15	$3.38	$3.35
⅝	2.20	**2.35**	3.34	3.10	3.25	3.43	3.45
¾	2.30	**2.45**	3.44	3.20	**3.40**	3.48	3.55
⅞	2.50	**2.65**	3.64	3.40	**3.70**	3.63	3.75
1	3.10	**3.25**	4.24	4.00	**4.35**	3.78	4.35

For size and cutting extras, manufacturers and distributors, see bar card of July 15, 1923.

ROLLED FROM RAILS

	Birmingham	St. Louis	Dallas		Birmingham	St. Louis	Dallas
½ and larger	.....	$2.85	$3.08	½	.....	$3.40	$3.30
⅝ in.	.....	2.95	3.13	⅝	.....	4.05	3.48
¾	.....	3.10	3.18	¾	.....	.....	.....

BRICK—Contractors price per 1,000 in cargo or carload lots is as follows:

	Common: Jan. 1	One Month Ago	One Year Ago	Paving Block: 3-inch*	4-inch*
New York (del.)	$18.00	$18.00	$23.65	$44.00†	$51.00†
New York (at dock)	15.00	15.00	20.00	.....	.....
Chicago	12.00	.....	11.00	50.00	50.00
St. Louis, salmon	14@16	14@16	16@18	.....	40@42.50
Denver, salmon	12.00	12.00	12.00	.....	.....
Dallas	*11.60*	12.10	11.60	35.00	.....
San Francisco	*14.50*	15.50	15.50	.....	.....
Los Angeles	*13.00*	15.00	14.50	(not used)	
Boston (del.)	21.00	21.00	21.00	47.00	55.00
Minneapolis (del.)	15.00	15.00	16@18	.....	.....
Kansas City	14.50	14.50	16.50	(no market)	
Seattle	*14.50*	15.00	15.00	.....	42.50
Cincinnati	17.00	17.00	20.00	40.00	45.00
Montreal	17.50	17.50	16.50	100.00‡	68.00
Detroit (del.)	17.50	17.50	18.25	38.50	41.50
Baltimore	18.00	18.00	21.00	40.00	45.00
Atlanta	10.50	10.50	11.00	40.00	.....
New Orleans	*15.00*	17.50	18.75	.....	.....
Birmingham	12.50	12.50	12.50@14	40.00	45.00
Philadelphia	19.00	19.00	21.00	38.00	46.00
Pittsburgh (del.)	16.00	16.00	16.00	.....	.....
Cleveland	14@16	14.00	16.00	.....	.....

*For paving blocks 3½x8½x3 and 3½x8½x4 respectively. †F.O.B. ‡Imported

HOLLOW TILE—Price per block in carload lots to contractor for hollow building tile.

	New York: Jan. 1 on Trucks*	One Year Ago	Chicago	Philadelphia	St. Louis	San Francisco	Perth Amboy N. J., Factory*
4x12x12	$0.1162	$0.1179	$0.06	$0.125	$0.072	$0.108	.....
6x12x12	.1743	.1769	.0825	.....	.097	.156	.....
8x12x12	.2179	.2211	.1125	.215	.132	.244	.....
10x12x12	.....	.....	.14	.....	.165	.....	$0.2388
12x12x12	.....	.....	.18	.....	.20	.....	.2956

*5 per cent off for cash.

	4x12x12	8x12x12	12x12x12
Boston	*$0.18*	*$0.22*	.....
Minneapolis (f.o.b. cars)	*.063*	.11	$0.195
Minneapolis (delivered)	.07	.12	.21
Cincinnati	.07485	.13745	.....
Kansas City	.074	.138	.....
Denver	.085	.155	.188
Seattle (delivered)	.11	.20	.30
Los Angeles	.085	.172	.....
New Orleans	*.0895*	*.1674*	.....
Detroit (delivered)	.0815	.1529	.....
Montreal	.12	.225	.30
Baltimore	.125	.27	.....
Atlanta	.1004	.1674	.....
Dallas	.0941	.1824	.285
Birmingham	.11	.175	.22
Pittsburgh (delivered)	.068	.128	.179
Cleveland	.064	.149	.....

San Francisco and New York quote on hollow partition tile.

STRUCTURAL MATERIAL—Following are base prices f.o.b. mill, Pittsburgh and Birmingham, together with quotations per 100 lb. from warehouses at place named:

	Pittsburgh Mill	Birmingham	Warehouse: New York	Dallas	St. Louis	Chicago	San Francisco
Beams, 3 to 15 in.	$2.10	$1.90@2.15	$3.34	$4.15	$3.25	$3.10	$3.00
Channels, 3 to 15 in.	2.10	1.90@2.15	3.34	4.15	3.25	3.10	3.00
Angles, 3 to 16 in., ¼ in. thick	2.10	1.90@2.15	3.34	4.15	3.25	3.10	3.00
Tees, 3 in. and larger	2.10	1.90@2.15	3.34	4.15	3.25	3.10	3.05
Plates, ¼ in. thick and heavier	2.00	1.90@2.15	3.34	4.15	3.25	3.10	3.00

RIVETS—The following quotations are per 100 lb.:

STRUCTURAL

	Pittsburgh Mill	Warehouse: New York Jan. 1	New York One Yr. Ago	Chicago	St. Louis	San Francisco	Dallas
½ in.	$2.60	**$4.25**	$4.40	*$3.50*	$3.65	**$5.00**	$4.75

CONE HEAD BOILER

½ in.	**$2.90**	**$4.35**	$4.50	*$3.70*	*$3.70*	**$5.20**	$5.00
⅝ and ¾	**3.05**	**4.50**	4.66	*3.80*	*3.85*	5.35	5.15
¾ and ⅞	**3.30**	**4.75**	4.90	*4.05*	*4.35*	5.60	5.50

NAILS—The following quotations are per keg from warehouse:

	Pittsburgh Mill	Birmingham	Chicago	San Francisco	Dallas	St. Louis	Montreal
Wire	**$2.85**	$2.90	$3.25	*$4.00*	*$4.25*	**$3.19**	4.95
Cut	2.90	3.10	....	5.25	5.00	**3.44**	5.00

SHIP SPIKES—Current prices per 100 lb.:

In.	San Francisco: Galv.	Black	Seattle Black
½	$8.00	$6.00	$7.75
⅝	7.30	5.30	5.40
¾	7.15	5.15	5.50

Pittsburgh base in lots of 200 kegs or more, $3.25.

PREPARED ROOFINGS—Slate-surfaced roofing (red and green) in rolls of 108 sq.ft. costs **$2.77 per roll** to consumers in less than carload lots f.o.b. Philadelphia.

Single shingles, red and green slate finish, cost **$7.56** per square (sufficient to cover 100 sq.ft.) in less than carload lots, f.o.b. Philadelphia. Strip shingles (4 in 1) f.o.b. Philadelphia, l.c.l., **$6.20** per square.

ROOFING MATERIALS—Prices f.o.b. New York, to consumers in less than carload lots:

Tar felt (14 lb. per square of 100 sq.ft.) per ton	**$89.75**
Tar pitch (in 400-lb. bbl.), per 100 lb.	*2.03*
Asphalt roofing (in barrels), per ton, f.o.b. plant*	**61.51**
Asphalt felt (light), per ton, f.o.b. plant*	**95.00**
Asphalt felt (heavy), per ton, f.o.b. plant*	**95.00**

* Delivered in Metropolitan Dist., $2.00 additional.

WINDOW GLASS—United inches, 25, bracket size 6x8 to 10x15, single thickness "AA," 82 per cent; "A," 86 per cent; "B," 88 per cent. Double thickness "AA," 82 per cent, "A," 85 per cent; "B," 88 per cent discount from jobbers list at New York warehouses.

SHEETS—Quotations are per 100 lb. in various cities from warehouse also the base quotations from mill:

Blue Annealed	Pittsburgh Large Mill Lots	St. Louis	Chicago	San Francisco	New York
No. 10	2.70	$3.90	$3.80	$3.95	$3.89
No. 12	2.80	3.95	*3.85*	4.00	3.94
No. 14	2.90	4.00	*3.95*	4.05	3.99
No. 16	3.10	4.10	*4.15*	4.15	4.09
Black					
*Nos. 18 and 20	3.45	4.45	*4.30*	4.80	4.40
*Nos. 22 and 24	3.50	4.50	*4.35*	4.85	4.45
*No. 26	3.55	4.55	*4.40*	4.90	4.50
*No. 28	3.60	4.65	*4.50*	5.00	4.60
Galvanized					
No. 10	**3.75**	4.65	*4.50*	**5.05**	4.60
No. 12	**3.85**	4.75	*4.60*	**5.15**	4.70
No. 14	**4.00**	4.75	*4.60*	**5.15**	4.70
Nos. 17 to 21	**4.15**	5.05	*4.90*	**5.45**	5.00
Nos. 22 and 24	**4.30**	5.20	*5.05*	**5.60**	5.15
*Nos. 25 and 26	**4.45**	5.35	*5.20*	**5.75**	5.30
*No. 28	**4.75**	5.65	*5.50*	**6.05**	5.60

* For painted corrugated sheets add 30c. per 1,000 lb. for 5 to 28 gage; 25c. for 19 to 24 gages; for galvanized corrugated sheets add 15c., all gages.

LINSEED OIL—These prices are per gallon:

	New York: Jan. 1	One Year Ago	Chicago: Jan. 1	One Year Ago
Raw in barrels (5 bbl. lots)	**$1.17**	$0.95	**$1.25**	$0.94

WHITE AND RED LEAD—In 100-lb. kegs, base price in cents per pound:

	Dry		In Oil	
	Jan. 1	1 Yr. Ago	Jan. 1	1 Yr. Ago
Red	$15 75	$14 00	$17 25	$15.50
White	15.75	14 00	15.75	14 00

Lumber

Prices wholesale, per M. ft. b m., to dealers in carload lots, f.o.b.

San Francisco—Prices of rough Douglas fir No. 1 common, in carload lots to dealers at yards. To contractors, $2 per M. ft. additional.

	6-8 and 12 Ft.	10-16-18 and 20 Ft.	22 and 24 Ft.	25 to 32 Ft
3x3 and 4	$28 00	$29 00	$30.00	$33 00
3x6 and 8	28.00	29 00	30 00	33 00
4x4-6 and 8	28 00	29.00	30 00	33 00
3x10 and 12	28.00	29.00	30 00	33.00
3x14	34 00	32 00	34 00	36 00
4x10 and 12	2. 00	29 00	30.00	33 00
4x14	34.00	32 00	34.00	36 00

	24 Ft. and Under	25 to 32 Ft.	33 to 40 Ft.
6x10	$30 00	$32 00	$34 00
6x14	35.00	37 00	39.00
8x10	30.00	32.00	34 00
8x14	36.00	37.00	39.00

New York and Chicago—Wholesale prices to dealers of long leaf yellow pine.

	New York*		Chicago	
	20 Ft. and Under	22-24 Ft.	20 Ft. and Under	22-24 Ft.
3x4 to 8x8	$43 00	$44.00	.....	.....
3x10 to 10x10	46 00	47.00	.....	.....
3x12 to 12x12	53 00	54.00	.....	.....
3x14 to 14x14	60 00	61 00	.....	.....
3x16 to 16x16	66.00	67.00	.....	.....
3x18 to 18x18	.....	.....	.....	.....
4x20 to 20x20	.....	.....	.....	.....

* Wholesale price to dealers; to contractors, delivered from lighters or cars to job, $5 additional. Short leaf pine costs $3 per M. less.

Over 24 ft.—Add $1 for each additional 2 ft. in length up to 30 ft. for sizes 12x12 and under, for sizes over 12x12 add $2. for merchantable add $2 to sizes 10x10 and under.

Other Cities	8x8-In. x 20 Ft. and Under				12x12-In. 20 Ft. and Under	
	P.	Fir*	Hemlock	Spruce	P.	Fir*
Boston	$54.00	$52.00†	$50.00	$50.00	$64.00	62 00†
Seattle	.....	29.50	.....	.....	.....	26.00
New Orleans	30 00	.....	.....	.....	40 50	.....
Baltimore	32 50	49.25	53.00	60.00	38.00	49.75
Cincinnati	40 00	74.00	74.00	88.00	44.00	78.00
Montreal	50.00	58.00	.....	.....	60.00	65.00
Los Angeles	.....	37.00	.....	.....	.....	38 00
Denver	.....	38.75	38 75	.....	.....	39.75
Minneapolis	42.00	39.75	39.00	.....	44 50	39.75
Atlanta	31.00	.....	.....	.....	34.00	.....
Dallas	52 25	.....	.....	.....	56.00	.....
Kansas City	39 50	.....	.....	.....	48.50	.....
Birmingham	32.00	.....	.....	.....	38.00	.....
Philadelphia	60 00	51.00	38.00	38.00	68.00	51.00
Detroit	40.25	48.75	.....	.....	51.75	48.75
St. Louis	38.25	.....	.....	.....	50.00	.....

	1-In. Rough, 10 In. x 16 Ft. and Under			2-In. T. and Gr. 10 In. x 16 Ft.	
	P.	Fir*	Hemlock	P.	Fir*
Boston	$45.00	$44.00†	$44.00	$52.00	$50.00†
Seattle	.....	25.00	.....	.....	29.00
New Orleans	70.00	.....	.....	35.00	.....
Baltimore	55.00	44.00	44.00	34.00	50.00
Cincinnati	75.00	80.00	75.00	38.00	88.00
Montreal	56.00	50.00	45.00	45.00	45.00
Los Angeles	.....	32.00	.....	.....	81.00
Denver	.....	35.25	35.25	.....	32.25
Minneapolis	44.00	37.75	35.50	38.00	35.25
Atlanta	19..0	.....	.....	29.00	.....
Dallas	52.25	.....	.....	55.75	.....
Kansas City	72.25	.....	.....	72.75	.....
Birmingham	63.00	.....	.....	67.00	.....
Philadelphia	33.50	30.00	37.00	60.00	31.00
Detroit	41.25	37.00	.....	45.50	37.75
St. Louis	43.00	.....	.....	31.00	.....

Birmingham—Quotes carload lots, f.o.b. sidings; $4.00 additional per M. ft. to contractors.
Boston and Cincinnati—Prices to contractors in carload lots, f.o.b.
Denver—Quotes dealers price to contractors on large projects.
St. Louis—Wholesale price to contractors, f.o.b. cars, $2 per M.ft. additional.
Seattle—Price to contractors, delivered.
Dallas—Wholesale to contractors, $10 per M.ft. additional.
*Douglas fir. †Prime.

PILES—Prices per lineal foot, pine piles with bark on, f.o.b. New York.

Diameters	Points	Length	Barge	Rail
12 in. at butt	6 in.	30 to 50 ft.	$0.14½	$0.18½
12 in.—2 ft. from butt	6 in.	50 to 59 ft.	.19	.23½
12 in.—2 ft. from butt	6 in.	60 to 69 ft.	.21½	.25½
14 in.—2 ft. from butt	6 in.	50 to 69 ft.	.25½	.34
14 in.—2 ft. from butt	6 in.	70 to 79 ft.	.27½	.36½
14 in.—2 ft. from butt	5 in.	80 to 89 ft.	.35	.41

Miscellaneous

STEEL SHEETPILING—The following price is base per 100 lb. f.o.b. Pittsburgh, with a comparison of a month and a year ago:

Jan. 1	One Month Ago	One Year Ago
$1.95@2.05	$1.95@2.05	$2.65

WIRE ROPE—Discounts from list price on regular grades of bright and galvanized are as follows:

	Eastern Territory New York and East of Missouri River
Plow steel round strand rope	35%
Special steel round strand rope	30%
Cast steel round strand rope	20%
Round strand iron and iron tiller	5%
Galvanized steel rigging and guy rope	7½%
Galvanized iron rigging and guy rope	+12½%

California, Oregon, Nevada and Washington Discount: 5 points less than discount for Eastern territory.
Wyoming, New Mexico and Colorado: Discount 5 points less than discount for Eastern territory.
Arisona: Discount 10 points less than discount for Eastern territory.
Montana, Idaho and Utah: Discount 10 points less than discount for Eastern territory.
North Dakota, Nebraska, Kansas, Oklahoma and Texas: Discount 5 points less than discount for Eastern territory.

MANILA ROPE—For rope smaller than ¼-in. the price is ½ to 2c. extra; while for quantities amounting to less than 600 ft., there is an extra charge of 1c. The number of feet per pound for the various sizes is as follows: ¼-in., 8 ft.; ⅜-in., 6; ½-in., 4½; ⅝-in., 3½; ¾-in., 2 ft. 10 in.; 1-in., 2 ft. 4 in. Following is price per pound for ¼-in. and larger, in 1200-ft. coils:

Boston	$0.17@.21	New Orleans	$0.21½
New York	.22	Los Angeles	.19
Chicago	.21½	Seattle	.17
Minneapolis	.23½	St. Louis	.22½
San Francisco	.21	Montreal	.16
Atlanta	.21	Detroit	.19
Denver	.25	Baltimore	.18
Cincinnati	.21	Kansas City	.20½
Dallas	.28	Birmingham	.19@.22
Philadelphia	.19		

EXPLOSIVES—Price per pound of dynamite in small lots:

	Gelatin 40%	Gelatin 60%
New York	$0.27	$0.295
Boston	.225	.25
Kansas City	.2125	.2325
Seattle	.165	.19
Chicago	.1525	.1775
Minneapolis	.1917	.2123
St. Louis	.22	.245
Denver	.2025	.2275
Dallas	.26	.302
Los Angeles	.1875	.2125
Atlanta	.23	.255
Baltimore	.22	.23
Cincinnati	.22	.245
Montreal	.195	.235
Birmingham	.23	.255
New Orleans	.235	.26
San Francisco	.1625	.1925
Philadelphia	.215	.24

CHEMICALS—Water and sewage treatment chemicals, spot shipments in Carload lots, f.o.b. New York:

Sulphate of aluminum, in bags, per 100 lb.	$1.40@1.45
Sulphate of copper, in bbl., per 100 lb.	4.65@4.75
Soda ash, 58%, in bags, per 100 lb.	1.25@1.45
Chlorine, liquid, cylinders, 100 lb., per lb. (f.o.b. works)	.05½@.07½
Hypochlorite of lime (bleaching powder) in drums, per 100 lb.	2.00@2.15

FREIGHT RATES—On finished steel products in the Pittsburgh district, including plates, structural shapes, merchant steel, bars, pipe fittings, plain and galvanized wire nails, rivets, spikes, bolts, flat sheets (except planished), chains, etc., the following freight rates are effective in cents per 100 lb., in carloads of 36,000 lb.:

Baltimore	$0.31	Detroit	$0.29
Birmingham	.58	Kansas City	.735
Boston	.365	New Orleans	.67
Buffalo	.265	New York	.34
Chicago	.34	Pacific Coast (all rail)	1.15*
Cincinnati	.29	Philadelphia	.32
Cleveland	.19	St. Louis	.43
Denver	1.15*	St. Paul	.60

* Minimum carload, 50,000 lb., structural steel only; 80,000 lb., for other iron or steel products.